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STAFF REPORT

SEDIMENT AND CHEMISTRY SURVEY
OF
PENNWALT CORPORATIONS WEST PLANT (RIVERVIEW, MICHIGAN)
AND
MONGUAGON CREEK
FOLLOWING THE LOSS (DECEMBER 31, 1977)
OF
DIBUTYL ZIRAM

January 5, 1978

By
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INTRODUCTION

In response to a request of January 4, 1978, by Robert Courchaine, Chief, Water Quality Division, and Roy Schrameck, District I Basin Engineer, a water and sediment sampling survey was performed January 6, 1978, on the settling lagoon system of the Pennwalt Corporation's West Plant located in Riverview, Michigan and Monguagon Creek. Monguagon Creek serves as the primary mixing zone and conveys Pennwalt's chemical waste and process waters to the Detroit River from Outfall 006. The request was in response to PEAS incident number 1445-77, in which Pennwalt lost an excessive, but undetermined quantity of zinc-dibutyldithiocarbamate (dibutyl ziram) on December 31, 1977 (Schrameck, 1978).

The primary purpose of the survey was to determine the extent of the loss of ~~dibutyl~~ ziram considered a mutagen and toxicant to fish. Dibutyl ziram is used in industrial processes primarily as a vulcanizing accelerator. The Department's Office of Toxic Materials Control (OTMC) provided information pertaining to a structural analogue zinc dimethyldithiocarbamate (dimethyl ziram) since little information was known or available for dibutyl ziram. Dibutyl ziram, a structural analogue of dimethyl ziram, was considered to exhibit similar toxic and mutagenic properties as dimethyl ziram.

The chemical evaluation on dimethyl ziram by OTMC places the compound on the State's Critical Materials Register owing to its moderate toxicity and mutagenicity to wildlife as well as a 96-hour LC 50 value of 0.008 mg/l for fathead minnows (McKee, 1971). Another characteristic of this compound is that it is practically insoluble in water. It eventually breaks down in soils under weathering conditions and, therefore, presumably under aquatic conditions. Little is known as to the rate of breakdown associated under aquatic conditions.

The eventual breakdown products include amines, carbon disulfide (CS_2) and zinc (Zn). Information from OTMC indicates the latter two are also on the Critical Materials Register. Analysis for the amine by-product was not performed whereas Zn and CS_2 were used as indicators of the dibutyl ziram compound.

a. CS_2 is slightly soluble in water at 20°C and exhibits a 96-hour LC 50 of 35 ppm for perch (Dawson et al, 1970). It is extremely volatile and flammable. Overall, CS_2, itself, is considered extremely toxic, in both aquatic and terrestrial conditions.

b. Zinc, another primary breakdown product, is considered toxic to aquatic life with reported 96-hour LC 50 values of 12.5 ppm for bluegills (Dawson et al, 1975). It, as well as the parent compound, is considered to have toxic, mutagenic and carcinogenic properties.

Again, for purposes of this survey and data evaluation, dibutyl ziram is considered to exhibit the same characteristics as dimethyl ziram including toxicity, carcinogenicity and mutagenicity.

PROCEDURES

The following individuals convened at the west plant for the sampling survey on January 5, 1978:

*C. W. Gullickson - Pennwalt Corporation
Roy Schrameck - District I, Water Quality Division
Brian Reicks - District I, Water Quality Division
Mike Kramer - U.S. Coast Guard
Dave Page - U.S. Coast Guard
John Wuycheck - Biology Section, Water Quality Division

*Mr. Gullickson was present only during the in-plant survey (Stations 1-7).

Sampling stations (Figure 1) were selected that potentially had been involved in the subject incident of December 31, 1977. Observations (Table 1) were made as well as the collection of water, foam and sediment samples in an attempt to document the loss of dibutyl ziram and determine the area of influence (Table 2). Analyses for other potential contaminants (Table 3) were also performed.

Water and sediment samples were collected at all stations whereas foam samples were collected at Pond 1 (Station 2) and Pond 4 (Station 6), only. The foam samples were taken for comparison with samples taken during the subject incident (December 31, 1977). The analytical value of the foam samples was not realized at the time of the survey. Both water and foam collections were stored in 250 ml glass jars.

Sediment samples were collected at each sampling station from depositional zones where the dibutyl ziram, having a specific gravity of 1.6, was considered more likely to have been deposited. The samples were taken using a cylindrical plastic scoop attached to a 3 to 6 m extendable handle. An apparent beige colored material had been deposited onto the sediment surfaces, particularly noticeable in Monguagon Creek that was considered attributable to the dibutyl ziram loss. Samples were taken from the upper 5.0 cm of sediment surface in an attempt to maximize the concentrations of this beige colored material. It was unavoidable, in taking the samples, to collect a significant amount of older sediments along with the more recent deposits layed down during the subject incident.

At each station at least 5 sediment scoops were composited in a white porcelin pan from which three aliquots were removed. Two aliquots from each station were each placed in a 250 ml glass jar for organic analysis with the remaining aliquot placed into a 250 ml plastic whirlpack for metals analysis.

Precautions were made to prevent cross contamination between sampling sites. All samples were stored at 4°C and returned, for analysis, to the Department's Environmental Services Division Laboratory using chain of custody procedures.

RESULTS

Indirect analysis for dibutyl ziram was made using a CS_2 evolution method (Keppel, 1971). Zinc analyses were also performed and with background levels substracted dibutyl ziram concentrations were determined. Equivalence factors (Table 2) were determined in order to calculate equivalent dibutyl ziram concentrations based on the CS_2, evolved and the zinc present in each sample.

In none of the samples was there any "free" CS_2. All the CS_2 determined for each sample analyzed was released from the dibutyl ziram in each sample by hydrolyzing each sample at the laboratory. The generated CS_2 was then trapped and quantified.

Survey results (Table 2) for water samples obtained from Outfall 006 (April 5-6, 1978) by the Department's Point Source Survey Section (Boersen and White, 1978) provided needed zinc and carbon disulfide background information (Table 2) that reflects zinc and carbon disulfide concentrations in the effluent uninfluenced by an ongoing dibutyl ziram production process. The dibutyl ziram production process had been shut down shortly after the subject incident and the background data represents levels of zinc and CS_2 attributable to other processes and/or influences by existing sediment conditions in the treatment ponds.

Table 4 represents zinc concentrations from the Company's MOR records that, more than likely, reflect influence by the dibutyl ziram production process. These concentrations in the effluent were discharged throughout the year 1977 and January 1978. MOR analysis results of water samples indicated zinc concentrations exceeding those levels observed during the dibutyl ziram loss. Table 5 indicates the total lbs/year of ziram (both dimethyl and dibutyl ziram), zinc and carbon disulfide reportedly discharged by the Company for the year 1977. This background information collectively provided a basis to evaluate the water analysis data collected January 5, 1978 and accurately determine the concentrations of dibutyl ziram in the water samples.

Based on observations alone, at least 15% to 25% of each sediment sample collected from Monguagon Creek was composed of the beige colored precipitate that was attributed to the dibutyl ziram loss. Corrected estimates of dibutyl ziram equivalents associated with the sediments are based on 20% of the sediments being the beige precipitate (Table 2).

Other parameters measured in the water, foam and sediment samples are presented in Table 3.

1. High concentrations of Zn and evolved CS_2, used as indicators of the presence of dibutyl ziram, were determined for the combined water-foam samples of December 31, 1977, taken from Ponds 1 and 4. These samples indicated that flows were high and that the treatment system was unable to cope with this situation since CS_2 and Zn concentrations were the same at both stations. No samples were taken in Monguagon Creek at that time.

2. January 5, 1978, samples of the combined water-foam samples of Ponds 1 and 4, when compared with the December 31, 1977 samples, showed CS_2 to be reduced by 80% and Zn concentrations reduced by 50% in Pond 1. In Pond 4 concentrations of CS_2 were only reduced by 50% whereas Zn concentrations doubled.

3. In water samples taken below Outfall 006 in Monguagon Creek CS_2 was obtained in samples taken at Jefferson Avenue during the January 6, 1978 survey that indicated the presence of dibutyl ziram in concentrations of 1.75 mg/l.

4. Zinc in the water samples of January 5, 1978 indicated dibutyl ziram equivalents of 13.9 mg/l existed, after the loss, at Bridge Road *just above the confluence with the Detroit River.*

5. Zn and evolved CS_2 concentrations were highest in the foam fraction samples indicating dibutyl ziram equivalents of 23,360 mg/l and 155 mg/l, respectively in Pond 4.

6. The foam samples also contained the highest concentrations of the other chemical parameters measured with the exception of phenols and ammonia which appeared to be in equilibrium with the water fraction.

7. CS_2 evolution from the sediment samples at the 2nd railroad bridge, just below Outfall 006 indicated dibutyl ziram was discharged into Monguagon Creek. The absence of CS_2 evolution from sediment samples of Jefferson Avenue and Bridge Road indicated that the dibutyl ziram compound had disassociated from the precipitate with eventual release of the CS_2 into the atmosphere from the water column.

8. A sample of frozen foam and settleable solids deposited on a *structural beam of the 2nd railroad bridge (Station 8-A) ca. 61.0 m* below Outfall 006 contained 98,000 mg/kg dry weight of zinc. This material similar in appearance as the beige precipitate was believed to have been deposited during the receding water conditions occurring after the increased water levels and flows observed during subject incident (December 31, 1977). This material was composed primarily of zinc and contained no CS_2 more than likely due to breakdown processes occurring during the 5-day period between the subject incident and the January 5, 1978 survey and eventual evolution. Based on zinc concentrations alone, estimated concentrations of 715,400 mg/kg dry weight of dibutyl ziram were <u>at one time</u> present at this location.

9. *Sediment samples from Ponds 1 and 4 showed that the sedimentation* system does reduce the concentrations of heavy metals and other measured compounds discharged from Outfall 006, but that sediment concentrations of total copper, chromium and nickel were moderately high with high zinc levels throughout Monguagon Creek to the confluence with the Detroit River. (Based on EPA contamination criteria for polluted spoils).

10. The sediments throughout the Company's treatment system indicated high concentrations of CS_2 considered attributable to the dibutyl ziram that precipitated to the sediments during the period between December 31, 1977 and January 5, 1978.

11. The extensive foaming observed on December 31, 1977, was not evident during the survey of January 5, 1978. Foam accumulations were limited to the Company's Pond #4 as well as the slack water areas and surface skimmers on Monguagon Creek at Jefferson Avenue.

DISCUSSION

On December 31, 1977 dibutyl ziram was discharged to the Company's settling pond treatment system involving a surge of process water resulting in excess foaming. This observed (Schrameck, 1978) surge of flows and foam productions resulted in a significant reduction in residence time necessary for treatment and containment causing excessive discharges of dibutyl ziram contaminated foam and precipitate to Monguagon Creek and Detroit River.

The dibutyl ziram lost during the subject incident (December 31, 1977) did not immediately enter the water column but was incorporated into the foam fraction at an estimated concentration of up to 10,950 mg/l based on zinc concentrations in foam samples taken at Outfall 006. Based on the water and foam samples, it is indicated that the treatment system on December 31, 1977 was unable to prevent the discharge of dibutyl ziram since extensive foaming was observed in Monguagon Creek. It is, therefore, indicated that dibutyl ziram at concentrations of at least 10,950 mg/l was discharged from Outfall 006 during the observed high flows of December 31, 1977, primarily in the form of foam.

The January 5, 1978 survey showed that the dibutyl ziram and/or breakdown products, zinc and carbon disulfide, were still associated with the foam fraction and that the disassociation of dibutyl ziram, as indicated by the reduced concentrations of CS_2, was occurring.

Zinc concentrations had increased in the foam fraction samples taken from Pond 4 on January 5, 1978 when compared to the earlier samples of December 31, 1977. Presumably this was due to decreased flows and turbulence observed on December 31, 1977, along with the loss of gasses from the foam matrix over the time interval. Based on water, foam and sediment samples from the inplant sampling program (Stations 1 through 7) the dibutyl ziram discharged from Outfall 006 was indicated to have been primarily associated with the excessive foam produced.

Once discharged to Monguagon Creek the foam containing dibutyl ziram began to breakdown and precipitate from the foam fraction due to reduced flows and reduced turbulence. The dibutyl ziram in the foam complex then precipitated into the water column producing the observed beige precipitate that eventually covered the darker, older sediments.

The breakdown of dibutyl ziram appeared to have begun while in the foam complex but also appeared to have taken place primarily after the dibutyl ziram had precipitated into the water column once flows had decreased. The precipitate then underwent further disassociation with the CS_2 fraction being released to the water column and eventually to the atmosphere due to its low solubility and high volatile characteristics. This phenomena was reflected by the apparent reduction or complete absence of CS_2 in the water and sediment samples taken at Jefferson Avenue and Bridge Road Downstream of the discharge.

Compared to Company 1977 MOR water analysis data, zinc concentrations in their effluent often exceeded levels documented during this subject incident and indicates loss of undetected incidences that potentially involved dibutyl ziram.

RECOMMENDATIONS

1. That Pennwalt Corporation be held accountable for violating their NPDES Permit by discharging excessive foam and suspended solids that contained the toxic material dibutyl ziram during the December 31, 1977 loss.

2. That the Pennwalt Corporation seriously consider the implimentation of a foam fractionation process in the treatment of their process waters. Based on this survey, the foam fractions contained appreciably higher concentrations of the parameters analyzed than did the water fraction. Therefore, intentional foam production and removal would significantly improve the quality of the effluent discharged to Monguagon Creek and Detroit River.

3. Considering the exotic nature of the materials used and produced by Pennwalt Corporation, a more thorough examination of effluent limitations should be performed by the Department in order to determine a proper effluent management program by the Company.

4. The Department should have Pennwalt Corporation dredge and properly dispose of contaminated sediments from Monguagon Creek. Since Monguagon Creek is potentially inhabitable by aquatic life including fish and macroinvertebrates the existing contaminated sludges and sediments would provide unsuitable and potentially toxic habitat.

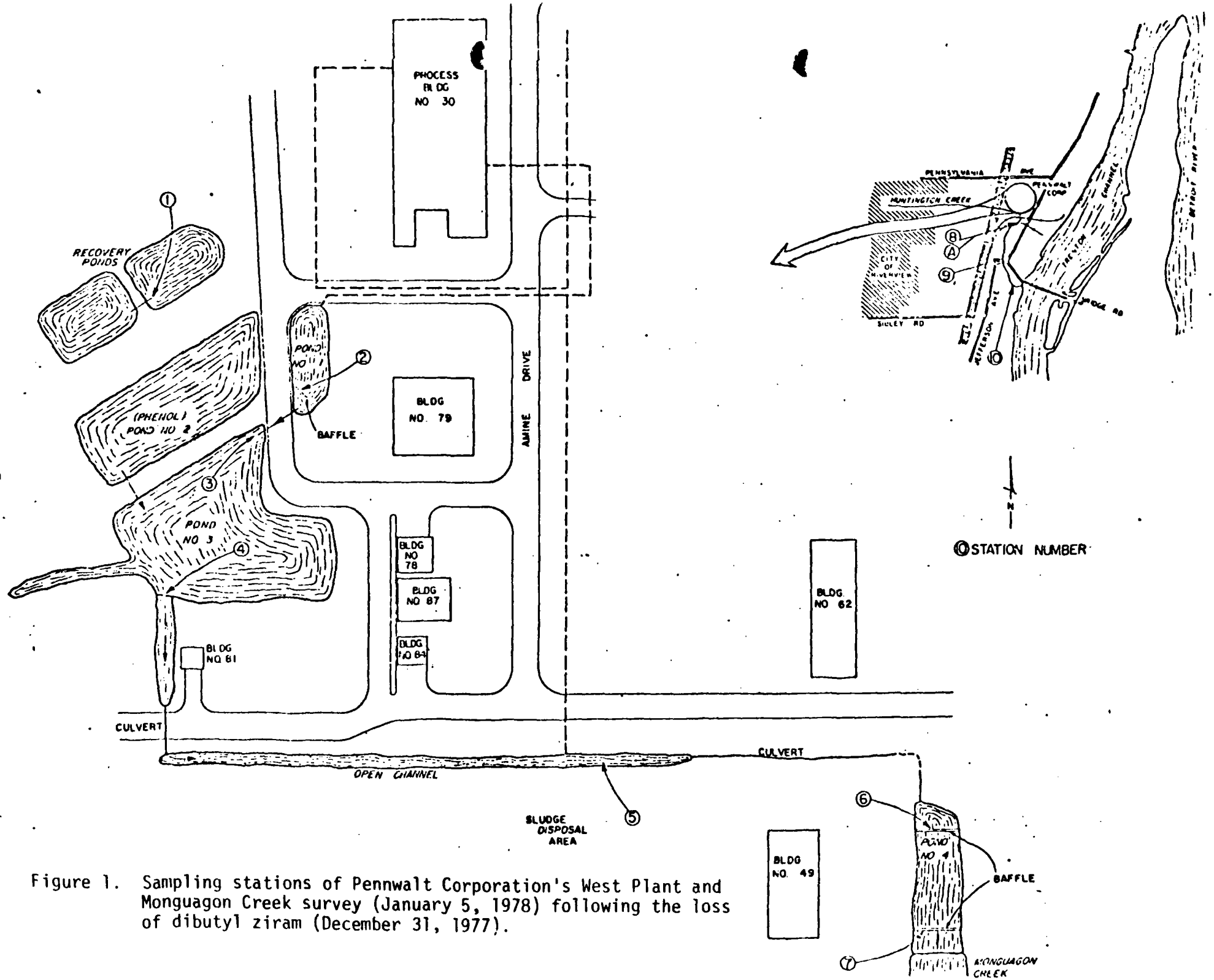

Figure 1. Sampling stations of Pennwalt Corporation's West Plant and Monguagon Creek survey (January 5, 1978) following the loss of dibutyl ziram (December 31, 1977).

Table 1 Station descriptions and observations associated with the sediment and water survey of the Pennwalt Corporation West Plant (Riverview, Michigan) on January 5, 1978, in response to a reported discharge of dibutyl ziram.

Sampling Station Number	River Point km (m)	Description and Observations
Station 1	In-Plant	Two lagoon systems located just west of Process Building #30, which was used for the dibutyl ziram recovery operation by the Marine Pollution Control Corporation (8631 W. Jefferson Avenue, Detroit, Michigan 48029). They had discharged recovered materials to the recovery ponds 5 minutes prior to sampling as well as during earlier recovery attempts. The sediments and water samples were composi samples taken from both the east outlet and west pond inlet, the only ponds in the survey which wer ice covered. The pond was turbid beige in color owing to the nature of the frozen foam associated with the subject incident being collected by the waste hauler team. Time: 11:20 AM
Station 2	In-Plant	Designated by Pennwalt Corporation as Pond #1, contained oily and tar-like sediments with an associated oily film on the water's surface. No ice cover was evident due to heat discharges and occasional gas bubbles could be seen at the water surface. Composited sediment samples were taken above and below the pond's single baffle near the outlet which discharged into Pond #3. Time: 11:45 AM Note: The Company designated Pond #2 was not sampled since it was not directly involved in the dibutyl ziram discharge. This pond contained black liquors and phenolic process wastes, in appearance, similar to concentrated oils which eventually discharged to Pond #3.
Station 3	In-Plant	Water samples were taken at the inlet to Pond #3. Sediment samples were taken from a sediment delta near the inlet containing a white layer of material presumed to be dibutyl ziram and/or breakdown products, overlaying the darker sediment base. Time: 11:50 AM
Station 4	In-Plant	Samples were taken from just above the outlet baffle of Pond #3, the sediments also exhibited a white layer of material presumed to be dibutyl ziram and/or breakdown products covering the underlying black sludge material. The discharge rates from the pond were lower than those observed during the subject incident by Roy Schrameck prior to the survey. The flow from Pond #3 entered a 2.0 m wide inter-connecting channel with Pond #4. Time: 12:07 PM
Station 5	In-Plant	Samples were taken from the drain connecting Ponds #3 and #4, ca. 30 m below the outlet of Pond #3, in a depositional area characterized by dark sediments overlain with a light colored layer. An upwelling 2.0 m above the point of collection was assumed to originate from the Company's 30" sewer line located east of Amine Drive. Time: 12:25 PM
Station 6	In-Plant	Samples were taken from the upper one-third of Pond #4 at the first baffle. The waters were green due to the chemical process water entering at this point covered, in quiet areas, with a beige colore foam. The water depth was ca. 2.6 m above the settled solids and this chamber represented the final treatment structure for the company's myraid of chemical wastes and by-products prior to the discharge to Monguagon Creek. Time: 12:45 PM

Table 1 (continued)

Sampling Station Number	River Point km	River Point (mi)	Description and Observations
Station 7	In-Plant		Samples were taken from just above the outlet of Pond #4, which formed the headwaters of Monguagon Creek. Sediments were composited from just above and below the final concrete baffle of the chamber. The water at this point was green owing to chemical process wastes, with noticeable beige colored foam on the surface.
Station 8	0.61	(0.38)	Samples were taken just above the 2nd railroad bridge ca. 61.0 m downstream from Pennwalt's final discharge. The stream was ca. 8 to 11 m wide with sludge banks 1.0 m in depth covered with a fine white particulate material (assumed to be dibutyl ziram and/or a breakdown product) near the stream margin. Signs of foam residues were apparent at this point and a beige particulate material was observed settling from areas of foam concentrations, into the water and then onto the sediment surface. This material was similar to what was on the sediment surfaces. No invertebrate forms were observed in this area. Time: 2:30 PM
Station 8A	0.61	(0.38)	Samples of a beige colored compound thought to be dibutyl ziram was removed from the RR bridge structure. This substance appeared to have been deposited during the subject incident when discharge waters were reduced. Water levels were estimated during this survey to be ca. 0.4 - 0.5 m lower than previously reported during the subject incident. Foam residues from the discharge were deposited on the bridge structure as well as settleable soilds. Time: 2:30 PM
Station 9	0.43	(0.26)	Located in Monguagon Creek 15 m above Jefferson Avenue (0.243 k) below Outfall 006. At this point, the stream was 11 m in width with a mean water depth of 0.6 m with a velocity of 0.33 m/s. Here the sediments were noticeably covered with a beige colored fine particulate material assumed to be dibutyl ziram or an associated by-product which had precipitated out from the foam complex. The water at this point omitted a strong chlorine smell which had not been apparent at any of the upstream stations and the only other possible source was considered to be Jones Industry located ca. 39 m upstream from Jefferson Avenue. No invertebrate forms were seen associated with sediments or water. Time: 3:05 PM
Station 10	0.06	(0.04)	Located just west of Bridge Road ca. 60 m above the confluence with the Detroit River at the Grosse Ile Fare Bridge. A layer of beige colored fine particulate material was observed covering the sediment surfaces. The chlorine odor continued to persist at this point. The stream was 11 m wide and 1.2 - 1.8 m in depth above the sampling site with noticeable sludge deposits in the streambed much as had been observed throughout Monguagon Creek. No living or dead aquatic organisms were observed on the instream solid substrate associated with some of the stream margin nor with the sludge type sediments. Time: 3:25 PM

Table 2 Water, foam and sediment analysis results (December 31, 1977 and January 5, 1978) showing concentrations (mg/l) of carbon disulfide (CS_2) and zinc (Zn) breakdown products of dibutyl ziram and estimates of dibutyl ziram equivalents.* Background values (April 5-6, 1978) obtained after dibutyl ziram production process shut down, were provided by the Point Source Survey Section. Corrected dibutyl ziram equivalents are based on subject incident zinc concentrations minus background concentrations after the dibutyl ziram production process was shut down.

		December 31, 1977		January 5, 1978				
				Station #1	Station #2	Station #3	Station #4	Station #5
Chemical Parameters	Equivalence Factors	Pond #1	Pond #4	Recovery Ponds	Pond #1	Pond #3 (inlet)	Pond #3 (outlet)	Channel
Water Fraction (mg/l)								
Free CS_2				<1	<1	<1	<1	<1
Generated CS_2		100	100	0.5	3.5	16	10	<1
* Dibutyl ziram equivalents	3.1	310	310	1.55	10.8	46.3	31	-
Total zinc		4.4	0.08	29	4.7	44	130	50
* Dibutyl ziram equivalents	7.3	32.1	0.58	211	34.3	321.2	949	365
Corrected dibutyl ziram equivalents								
Foam Fraction (mg/l)								
Generated CS_2					20			
* Dibutyl ziram equivalents	3.1				61.8			
Total zinc		1,900	1,500		25			
* Dibutyl ziram equivalents	7.3	13,870	10,950		182.5			
Sediments Fraction (mg/kg dry wt.)								
Generated CS_2				1,200	10,000	37,000	75,000	330
* Dibutyl ziram equivalents	3.1			3,700	31,000	114,000	232,500	1,023
Total zinc				320	7,700	44,000	40,000	18,000
* Dibutyl ziram equivalents	7.3			2,336	56,210	321,200	292,000	131,400

Table 2 (continued)

Chemical Parameters	Equivalence Factors	January 5, 1978 Station #6 Pond #4 (inlet)	Station #7 (outfall 006) Pond #4 (outlet)	Station #8 2nd RR Bridge	Station #8A 2nd RR Bridge Structure	Station #9 Jefferson Ave.	Station #10 Bridge Rd.	Background Values April 5-6, 1978 Outfall 006 Composite	single grabs 1	single grabs 2	Mean value
Water Fraction (mg/l)											
Free CS_2		<1	<1	<1		<1	<1				
Generated CS_2		ND	ND	ND	ND	0.5	ND		<0.1	<0.1	
* Dibutyl ziram equivalent	3.1					1.75					
Total zinc		100	3.6	3.8		3.2	2.4	0.7	0.33	0.66	0.495
* Dibutyl ziram equivalent	7.3	730	26.3	27.7		23.4	17.5				
Corrected Dibutyl ziram equivalents			22.6	24.1		19.7	13.9				
Foam Fraction (mg/l)											
Generated CS											
Generated CS_2		50									
* Dibutyl ziram equivalents	3.1	155									
Total zinc		3,200									
* Dibutyl ziram equivalents	7.3	23,360									
Sediments Fraction (mg/kg dry wt.)											
Generated CS_2		1,000	250	150	ND	ND	ND				
* Dibutyl ziram equivalents	3.5	3,100	775	465							
Total zinc		64,000	9,000	3,600	98,000	2,000	3,500				
* Dibutyl ziram equivalents	7.3	467,200	65,700	26,280	715,400	14,600	25,550				
*Dibutyl ziram equivalents based on 20% of zinc concentrations in sediment samples				5,256		2,900	5,110				

Table 3 Other parameters determined for water, foam and sediment samples taken on December 31, 1977 and January 5, 1978 at the Pennwalt Corporation West Plant (Riverview, Wayne County).

	December 31, 1977		January 5, 1978				
			Station #1	Station #2	Station #3	Station #4	Station #5
Chemical Parameters	Pond #1	Pond #4	Recovery Pond	Pond #1	Pond #3 (inlet)	Pond #3 (outlet)	Channel
Water Fraction (mg/l)							
Ammonia-N (NH_3)			1.91	0.29	0.91	2.8	1.3
Phenols			0.28	0.12	0.09	0.95	0.34
Hexavalent Chromium (Cr^{+6})	3.3	10.4	0.01	< 0.01	< 0.01	< 0.01	< 0.01
Total Chromium (Cr)			0.06	0.01	0.07	0.18	0.09
Total Nickel (Ni)			0.13	0.11	0.05	0.14	0.14
pH (SU)	3.3	10.4	9.6	6.8	6.7	3.1	9.4
Foam Fraction (mg/l)							
Ammonia-N (NH_3)				0.32			
Phenols				0.09			
Total Chromium (Cr)				0.01			
Total Nickel (Ni)				0.61			
pH (SU)				6.9			
Sediment Fraction (mg/kg dry wt.)							
Ammonia-N (NH_3)			13	100	37	21	160
Total Kjeldahl-N			11,000	9,900	12,000	9,700	5,200
Phenols			2.7	5.5	12	6.3	6.6
Total Chromium (Cr)			8	30	30	78	97
Total Copper			52	79	70	72	120
Total Cyanide			0.03	0.16	0.13	< 0.01	0.09
Total Nickel			100	170	660	130	410

Table 3 (continued)

Chemical Parameters	Station #6 Pond #4 (inlet)	Station #7 (outfall 006) Pond #4 (outlet)	Station #8 2nd RR Bridge	Station #9 Jefferson Ave.	Station #10 Bridge Road
	January 5, 1978				
Water Fraction (mg/l)					
Ammonia-N (NH_3)	1.23	0.14	0.16	0.21	0.15
Phenols	0.17	0.07	0.20	0.09	0.04
Hexavalent Chromium (Cr^{+6})	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Total Chromium (Cr)	0.14	< 0.01	< 0.01	< 0.01	< 0.01
Total Nickel (Ni)	0.29	< 0.05	< 0.05		
pH (SU)	10.0	8.5	8.6	9.5	9.3
Foam Fraction (mg/l)					
Ammonia-N (NH_3)	0.23				
Phenols	0.11				
Total Chromium (Cr)	3.0				
Total Nickel (Ni)	8.6				
pH (SU)	8.2				
Sediment Fraction (mg/kg dry wt.)					
Ammonia-N (NH_3)	140	110	32	37	58
Total Kjeldahl-N	6,000	5,500	4,100	2,400	2,800
Phenols	8.7	10	6.7	1.0	0.83
Total Chromium (Cr)	250	140	120	50	74
Total Copper	250	130	110	63	81
Total Cyanide	0.3	0.13	< 0.01	0.06	0.12
Total Nickel	710	320	290	69	140

Table 4 Monthly Operating Report of zinc concentrations (mg/l) reported by Pennwalt Corporation for the year 1977 and January of 1978.

	Monthly Operating Reports Zinc Concentrations (mg/l)	
	Single and Composite Samples	$\bar{x}$ Monthly Discharges
January 1977	.058 and 0.36	.047
February	3.130* and 0.631*	1.881
March	0.120, 2.810 and 1.120	1.350
April	0.124 and 0.275	0.199
May	0.085 and 0.586	0.335
June	0.667, 4.110 and 0.293	1.690
July	0.148 and 0.257	0.202
August	0.104* and 0.142	0.123
September	0.149* and 0.159*	0.154
October	2.450* and 15.400*	8.925
November	0.208*	0.208
December	3.180* and 4.76	1.828
January (1978)	8.680 (4th) and 0.725	4.702

* = composite samples

Table 5

Ziram, carbon disulfide and zinc (lbs/yr) discharged by the Pennwalt Corporation West Plant (Outfall 006) as reported in the Company's 1977 Wastewater Outfall Report.

Critical Materials	Quantity (lbs/yr)
Ziram	1,000 to 10,000
Carbon Disulfide	None
Zinc	10,000 to 100,000

Flow volumes*: maximum = 8.0 MGD
$\bar{x}$ daily flow = 6.7 MGD

* The 1976 Point Source Survey reported 9.3 MGD and the 1978 Point Source Survey reported a daily average of 5.9 MGD.

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Field Work By: Roy Schrameck, Basin Engineer, District I
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Chemical Analyses By: Environmental Services Division Laboratory

Drawings By: Michael Jones

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Water Quality Division
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8/15/78 Michigan Department of Natural Resources

Michigan Department of Natural Resources
Water Quality Division
June, 1980

An Evaluation of Stream Quality Problems in the Vicinity of Jones Chemical, Monguagon Creek, Riverview, Michigan February, 1980

On February 12, 1980, Jack Bails, Chief, Environmental Enforcement Division, requested by memo, an evaluation of the impacts of unpermitted discharges from Jones Chemical on Monguagon Creek's sediments and aquatic organisms. As requested, the stream was surveyed during the week of February 18, 1980. The impacts of the large upstream Pennwalt Corporation discharge, were of necessity, also evaluated.

FINDINGS

1. The discharge of very high concentrations (more than 1,000 mg/l) of extremely toxic chlorine from Jones Chemical via an unpermitted discharge has severely damaged Monguagon Creek. Macroscopic bottom dwelling stream life was absent downstream from the discharge for at least 0.15 km (kilometers).

2. Toxic heavy metals have been discharged from Jones Chemical as sediment concentrations of zinc (18,000 mg/kg) and lead (920 mg/kg) were markedly elevated below the discharge and were also found at high levels in a discharge sump at the facility.

3. One dead and one distressed fish (gizzard shad) were observed in Monguagon Creek below the Jones Chemical discharge. No other fish were observed.

4. The potential for untreated human waste discharges to Monguagon Creek from Jones Chemical was apparent as toilet tissue was observed in the unpermitted discharge containing chlorine. High fecal coliform counts were also found at an in-plant sump connected with the discharge pipe.

5. Suspended solids in runoff from Jones Chemical were high (490 mg/l) and formed an obvious deposit on the bottom of Monguagon Creek.

6. Pennwalt Corporation's discharge upstream of Jones Chemical is apparently the major source of PCB's and oils in Monguagon Creek sediments, and is also a significant source of toxic heavy metals. Most sediment contaminants in areas impacted by the Pennwalt discharge exceeded the U.S. EPA "heavily polluted" levels for dredge spoils.

7. A visible sheen of oil was observed on Monguagon Creek downstream of the Pennwalt Corporation's discharge (006) at all times during the study. This is a violation of their NPDES permit No. MI0002381.

8. The Pennwalt Corporation's discharge caused some damage to Monguagon Creek as indicated by the numbers, kinds and weight of macroscopic bottom dwelling organisms.

9. Monguagon Creek, upstream of the Pennwalt Corporation and Jones Chemical discharges, is a degraded stream with limited numbers and kinds of bottom dwelling organisms. Oils and some heavy metals in these sediments exceeded U.S. EPA "heavily polluted" levels but were considerably lower than those found downstream. Urban runoff, oil spills or unknown discharges are possible sources for contaminants.

RECOMMENDATIONS

1. The discharge of chlorine and heavy metals from Jones Chemical to Monguagon Creek should be eliminated or reduced significantly to acceptable concentrations. Sediments in this facility's stormwater runoff should be controlled. Discharge of untreated human wastes to the in-plant sump should cease.

2. The highly contaminated sediments should be removed from Monguagon Creek from Pennwalt's discharge to the Detroit River.

3. The Pennwalt Corporation's waste treatment should be upgraded to meet NPDES permit limits.

4. A sediment and biological survey should be conducted upstream of this Mongaugon Creek study area to determine other source(s) of sediment contaminants.

METHODS

Stream bottom dwelling animals (benthic macroinvertebrates), sediments, water and selected discharges of concern in the lower reaches of Monguagon Creek in the vicinity of Jones Chemical and the Pennwalt Corporation were sampled from a boat on February 20, 1980. All samples were maintained in chain of custody.

Five stations were established (Figure 1). Station A was the most upstream station (stream km 1.38) and located outside the area of impact of Pennwalt's discharge (station B - km 1.20). Station C (km 0.75) was immediately upstream of the Jones Chemical discharges while Station D (km 0.68) was immediately downstream. Station E (km 0.53) was further downstream where mixing appeared complete and upstream of other discharges. Storm sewers and runoff from roads, coal piles and the industrialized vicinity enter Monguagon Creek in the 0.53 km before its confluences with the Trenton Channel (Detroit River).

Water samples were handled and preserved according to U.S. EPA approved methods. Analysis for fecal coliform bacteria and suspended solids were completed in the Environmental Protection Bureau (EPB) laboratory in Lansing. Chlorine analysis was completed at the nearby Wayne County Public Works laboratory because of this element's instability over relatively short time periods.

Sediment and benthic macroinvertebrate samples were collected with a petite ponar bottom grab (15 cm x 15 cm). A 250 ml wide mouth bottle of sediment was collected, kept cool and returned to the EPB laboratory for analysis. Single sediment samples were collected near midstream at stations where a point source of pollution was judged not to have an effect along one streambank (stations A, B and E). At stations C and D a sediment sample was collected near each bank (Figure 2).

Figure 1. Location and sampling stations on Monguagon Creek, Wayne County, Michigan, February 20, 1980.

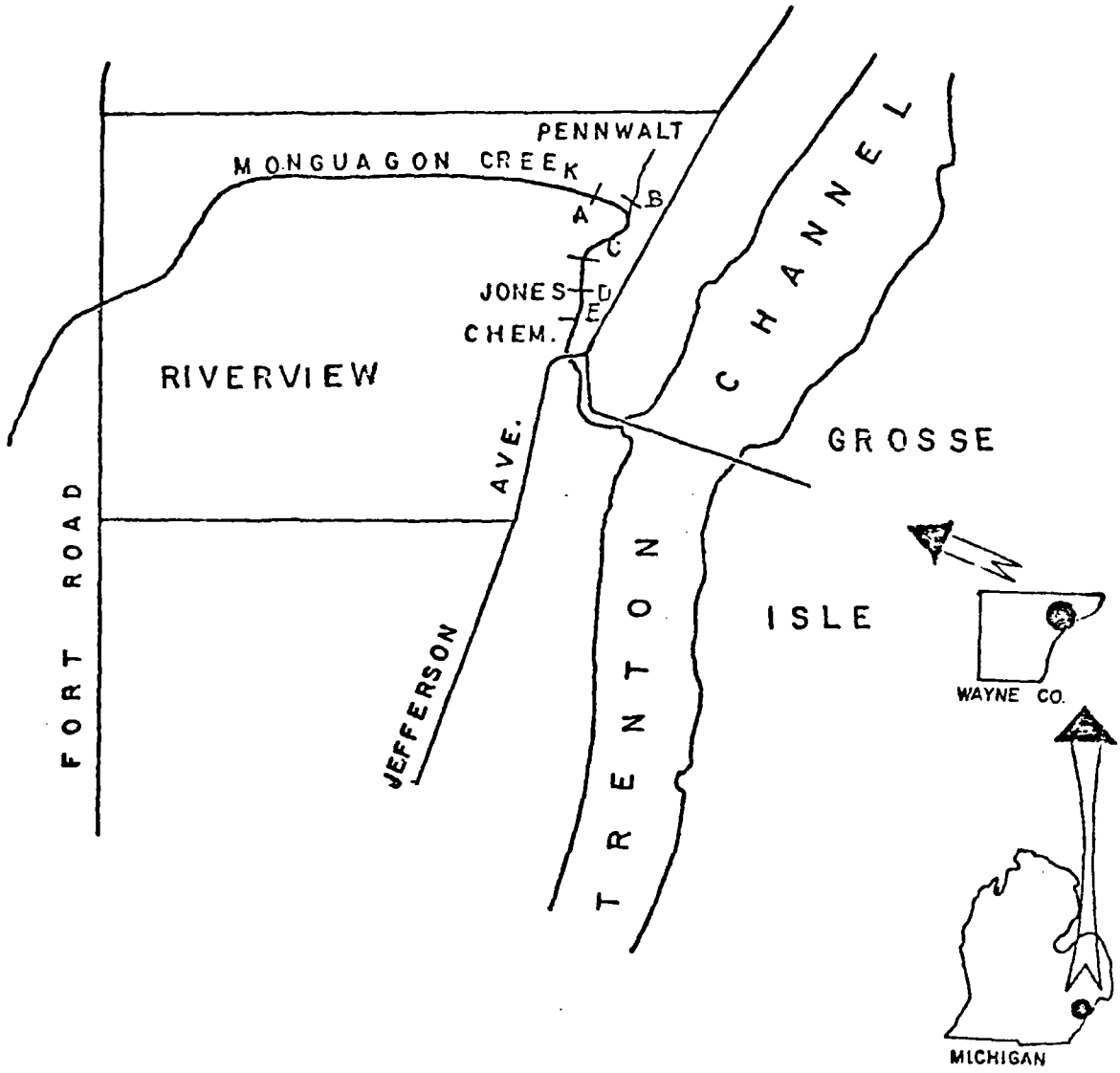
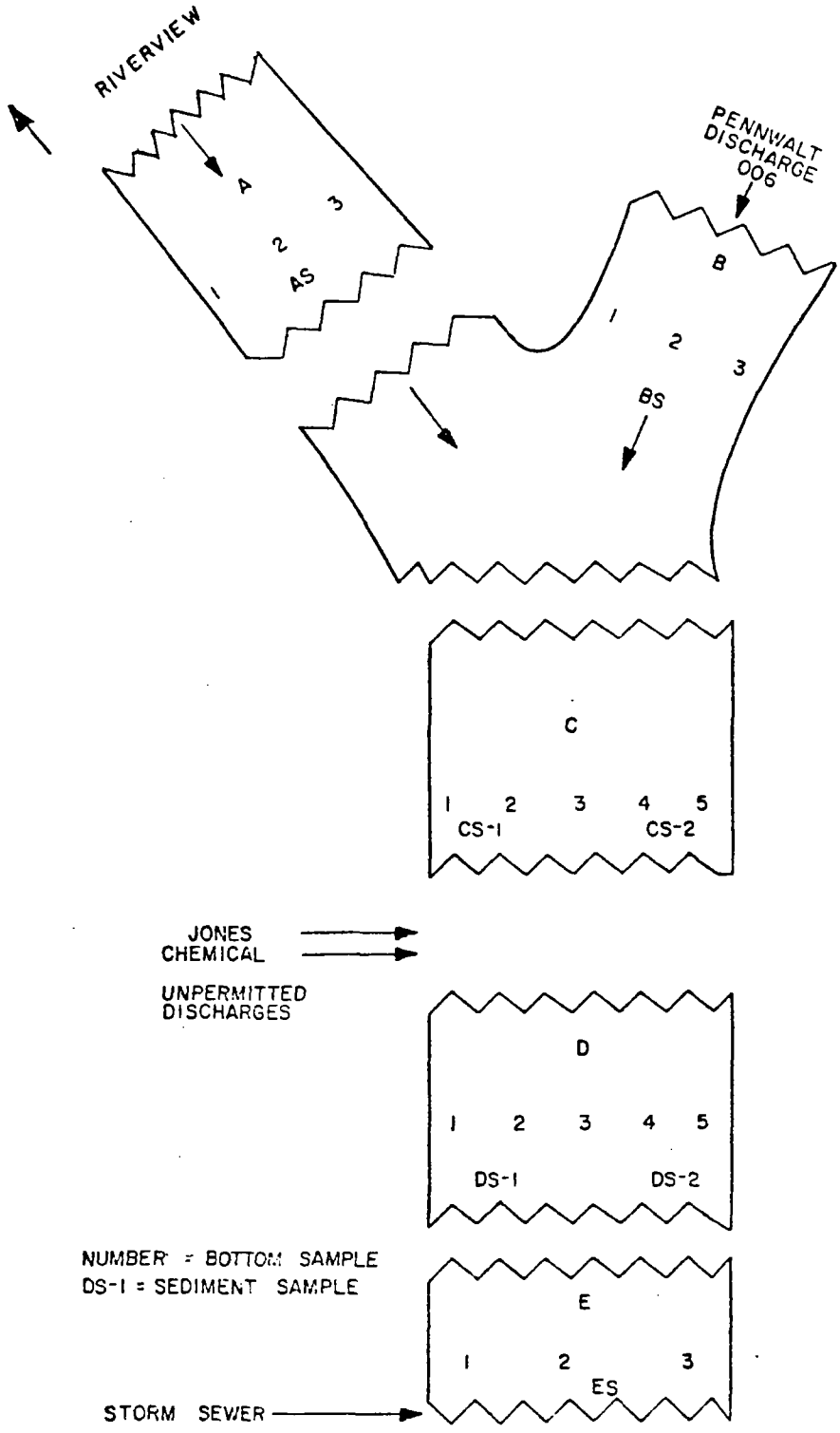


Figure 2. Detailed sampling locations for water, sediments and benthic macroinvertebrates in Monguagon Creek, Wayne County, Michigan, February 20, 1980.



Macroinvertebrate samples were collected on transects across Monguagon Creek. Samples were collected at points equidistant from the streambanks and each other along the transect. Three macroinvertebrate samples were taken where the stream was relatively narrow (stations A, B and E) while five samples were collected at stations C and D.

Samples taken with the ponar bottom grab were emptied into a small plastic tub to facilitate sample transfer into plastic bags. Samples were kept cool and returned to the Water Quality Division Biology Laboratory where they were washed in a U.S. Standard 30 mesh sieve bucket the following day. Sample remains after sieving were placed in widemouth quart jars and preserved with formalin. Animals were later removed from the sample using a 4x sorting lens, identified and counted with the aid of a dissecting microscope and weighed. All values have been multiplied by a correction factor (43) to convert raw data to numbers or grams weight per square meter. Animals to be weighed were placed on a paper towel for about a minute to remove water and weighed to the nearest 0.01 gram on a Mettler balance Model P162. After weighing, the animals were placed in a permanent storage solution in 4 dram screw top vials and retained under lock and key for further reference if necessary.

At each sampling site a station card was filled out to record general obvervations and/or conditions at the time. Photographs were also taken upstream and downstream from each sampling station. Photos from stations D and E were not usable because of accidental film exposure.

BACKGROUND

Monguagon Creek is located in southeastern Michigan in Wayne County and flows to the Trenton Channel (Detroit River) near Grosse Ile. The creek is named Huntington Creek on the USGS Wyandotte quadrangle 7.5 minute topographic map of 1973. Although not named on official Michigan County maps, Monguagon Creek is the recognized local name and appears on NPDES discharge permits.

Monguagon Creek is a first order stream (lacks tributaries) and has a total length of about 4.2 km. The once in 10 year 7-day low flow has been estimated at 0.0 m^3/day. The stream flows from its headwaters northeast to Riverview then west to the Detroit River. About 1.2 km upstream from its Detroit River confluence, the Pennwalt Corporation discharges 32,700 m^3/day of treated wastewater via discharge 006 under an NPDES permit (number MI0002381). A half kilometer downstream, Jones Chemical had two unpermitted discharges. Additional water and contaminants enter the stream from stormsewer discharges and urban or industrial runoff both upstream and downstream of the study area.

Most of the stream in Riverview has been enclosed. All of the stream has been channelized for drainage improvement and some sections have been dredged more than once to remove accumulated materials. In the 1950's, raw sewage from Riverview was discharged into the creek and extensive fish kills occurred on occasion (Robert Parker - personal communication). Sewage discharges have since been removed.

The unpermitted discharge from Jones Chemical to Monguagon Creek was found during an aerial reconnaissance flight on December 17, 1979 by William Murphy,

Environmental Enforcement Division, Department of Natural Resources (DNR). Photographs of the area taken at that time clearly show a discharge plume into the creek (DNR Exhibit No. __).

Since the discovery of the unpermitted Jones Chemical and prior to this study, sampling of the discharge, waste streams in the facility and the creek were undertaken. Lawrence Epskamp, District 14 Conservation Officer, Law Division collected water samples upstream and downstream of the discharge and from the surface and bottom of the discharge on February 9, 1980. The pH of the discharge was 11.3 at its surface and 15.7 at the bottom. Both are extremely alkaline pH values and would not be permitted. Sodium (9100 mg/1), chlorides (7400 mg/1) and sulfates (320 mg/1) were very high (Appendix I) in this discharge.

William Stone, District I, Water Quality Division, accompanied by William Murphy, collected water and sediment samples within the Jones Chemical facility on February 14, 1980. An in-plant sump had extremely high levels of iron (280,000 mg/kg), lead (3400 mg/kg), and zinc (1500 mg/kg) in the semi-fluid sediments in the sump bottom (Apprndix II). Chlorine ranged from high to very high in six of seven locations sampled within the facility. Chlorides and sodium followed a similar pattern to chlorine, with the water designated "pipe to sump" field ID number one (1) and having the lowest values and the sample designated "from NaOCl product tank", field ID number seven (7), having the highest value (Appendix III). Very high coliform bacteria counts were found in samples from an outside sump and indicated that untreated human wastes (Appendix IV) were in the Jones Chemical wastewaters prior to discharge.

White (1979) evaluated Pennwalt's discharge (006) as to its potential toxic effects on aquatic animals in Monguagon Creek and concluded that toxic conditions would exist as a result of the discharge. She found the NPDES permit limits for BOD_5, suspended solids and ammonia were exceeded and recommended that Pennwalt's NPDES permit limitations for ammonia and pH be revised.

RESULTS AND DISCUSSION

Water Quality

During the biological survey, water samples were collected and analysed for chlorine by staff of the nearby Wayne County Public Works laboratory. Sample #2 was collected in Pennwalt's discharge (station B) and had 4.3 mg/1 total chlorine (Appendix V). Above Jones Chemical (#3, station C) only free chlorine at 0.1 mg/1 was detected. The Jones Chemical discharge (#4) had 9900 mg/1 total chlorine. The pH of the discharge at the time, as estimated by indicator paper, was approximately 12. No discharge plume was evident in the stream during this study probably as a result of reduced flows. Downstream at station E (#5) free chlorine decreased to 0.4 mg/1 and total chlorine to 1.4 mg/1 (PPM equals mg/1) even under reduced discharge flows.

Recommended concentrations of total chlorine in discharges is 0.024 mg/1 at the edge of the mixing zone and concentrations of chlorine are not to exceed 0.5 mg/1 in the discharge in Michigan. Chlorine is a very toxic substance (Brungs, 1976), and should be greatly reduced in the Jones Chemical discharge as it was almo 20,000 times the discharge concentration limit. Chlorine concentrations should also be reduced in the Pennwalt discharge to acceptable levels.

An oil sheen was observed in the Pennwalt discharge channel and at all downstream stations during this study (Appendices X-XIII). This is in violation of the NPDES discharge permit which stipulates "no visible film" in Monguagon Creek.

A single water sample collected February 20, 1980 from a 15 cm (6 inch) diameter steel pipe (#1 discharge) apparently discharging stormwater runoff and/or snow melt at the time, had 490 mg/l suspended solids (lab sheet not included) and resulted in sediment deposition in the stream (Figure 3). Some control measures should be sought for this discharge.

Another water sample was taken from the other Jones Chemical discharge (#2) in which the extremely high levels of chlorine were found and analyzed for fecal coliform bacteria. Counts of fecal bacteria were less than 100 per 100 ml as would be expected with high levels of chlorine (Appendix IV). Toilet paper was seen in the effluent at the time of sampling (Appendices XI and XII). Whenever chlorine was not being discharged, raw sewage could have been discharged. In either case, treatment of human wastes would have been inadequate.

Sediment Contaminants

Substances such as heavy metals, oils and synthetic organic compounds which are relatively insoluable in water will usually be found in stream or lake sediments at concentrations many times higher than can be found in the water. Contaminants of this type will also remain bound in sediments for extended time periods and thus reflect past discharges of contaminants. Many of these sediment contaminants are toxic to aquatic life when concentrations are elevated. Presently, the degree of sediment contamination or its pollutional status is based on the 1977 EPA dredge spoils criteria.

Using EPA's criteria as a basis for comparison, all stations had "heavily polluted" sediments for a number of parameters. At station A, oil (5500 mg/kg) arsenic (12 mg/kg), zinc (440 mg/kg), lead (90 mg/kg), iron (25,000 mg/kg), copper (50 mg/kg) and PCB (10 mg/kg) (Appendix VI) were the contaminants above the non-polluted level of the EPA (1977) dredge spoils criteria (Appendix VII). These sediment contaminants have probably reached Monguagon Creek via urban runoff or discharges upstream in the City of Riverview or from landfills and nearby industrialized areas.

In Pennwalt's discharge channel (station B) and downstream at station C every parameter, except iron, at least doubled in concentration in sediments. In addition, cyanide (5-6 mg/kg), cadmium (6-10 mg/kg), nickel (90-120 mg/kg), and mercury (2 mg/kg) were found at "heavily polluted" areas.

Immediately downstream of the Jones Chemical discharges most sediment contaminant concentrations (station D) were similar to those found upstream at Station A or C. However, higher concentrations of copper, iron, nickel, lead, zinc and manganese existed in the sample collected nearest Jones Chemical. Zinc values were 4700 mg/kg in this sample and 2500 mg/kg in the sample across the stream. As indicated before by Stone's data, the Jones Chemical discharge probably contained high levels of lead, zinc and iron. Zinc was apparently being precipitated quickly once it reached the stream and other metals at lower rates.

Downstream at station E the concentration of lead (920 mg/kg), nickel (230 mg/kg), copper (250 mg/kg), chromium (390 mg/kg), cadmium (10 mg/kg) and cyanide (12 mg/kg) about doubled again. Zinc was found at 18,000 mg/kg, an extremely high sediment

FIGURE 3. Discharge (#1) from Jones Chemical bearing suspended and settleable solids, with associated deposition in Monguagon Creek, February 20, 1980. Photograph by Frank Horvath.

concentration. These very high levels of contaminants probably existed at this location mainly as a result of discharges from Pennwalt and Jones Chemical. The marked increase in certain of the above parameters in downstream sediments at station E was probably the result of additional loadings of heavy metals from Jones Chemical and the chemical reaction and precipitation of these substances after the highly chlorinated Jones Chemical discharge were mixed with the receiving waters.

Macroinvertebrates

Animal communities living in or on the bottom of lakes and streams are the best indicators of aquatic environmental conditions. These animal communities are ubiquitous in undisturbed streams. Benthic or bottom dwelling animal species which together constitute a benthic community live most or all of their lives in the water. Aquatic insects, with rare exception, leave the water for short periods to mate and lay eggs but their immature larval stages may exist for more than a year in an aquatic environment. Aquatic worms (oligochaetes) spend all their lives in the aquatic environment. During this extended period of aquatic development they react to a myriad of physical and chemical parameters and thus are indicators of past environmental conditions.

A stream comparable in size to Monguagon Creek, under relatively unmodified stream conditions, would have benthic communities made up of many species of animals without a dominant species or species group. Biomass (weight per unit area) would usually be at intermediate levels (10-50 gm/m^2 wet weight) and distributed among a number of species. Macroinvertebrate density (number per unit area) would usually range from 1-5000/m^2. Discharges of pollutants in sufficient quantities results in marked and easily detected changes in benthic community structure. Sensitive species or species groups are eliminated and the benthic community becomes dominated by more pollution tolerant forms. Under moderately polluted conditions some forms may thus reach extreme densities and biomass. If pollution is increased further, all the above benthos parameters decrease. In the most extreme situations benthic communities are absent.

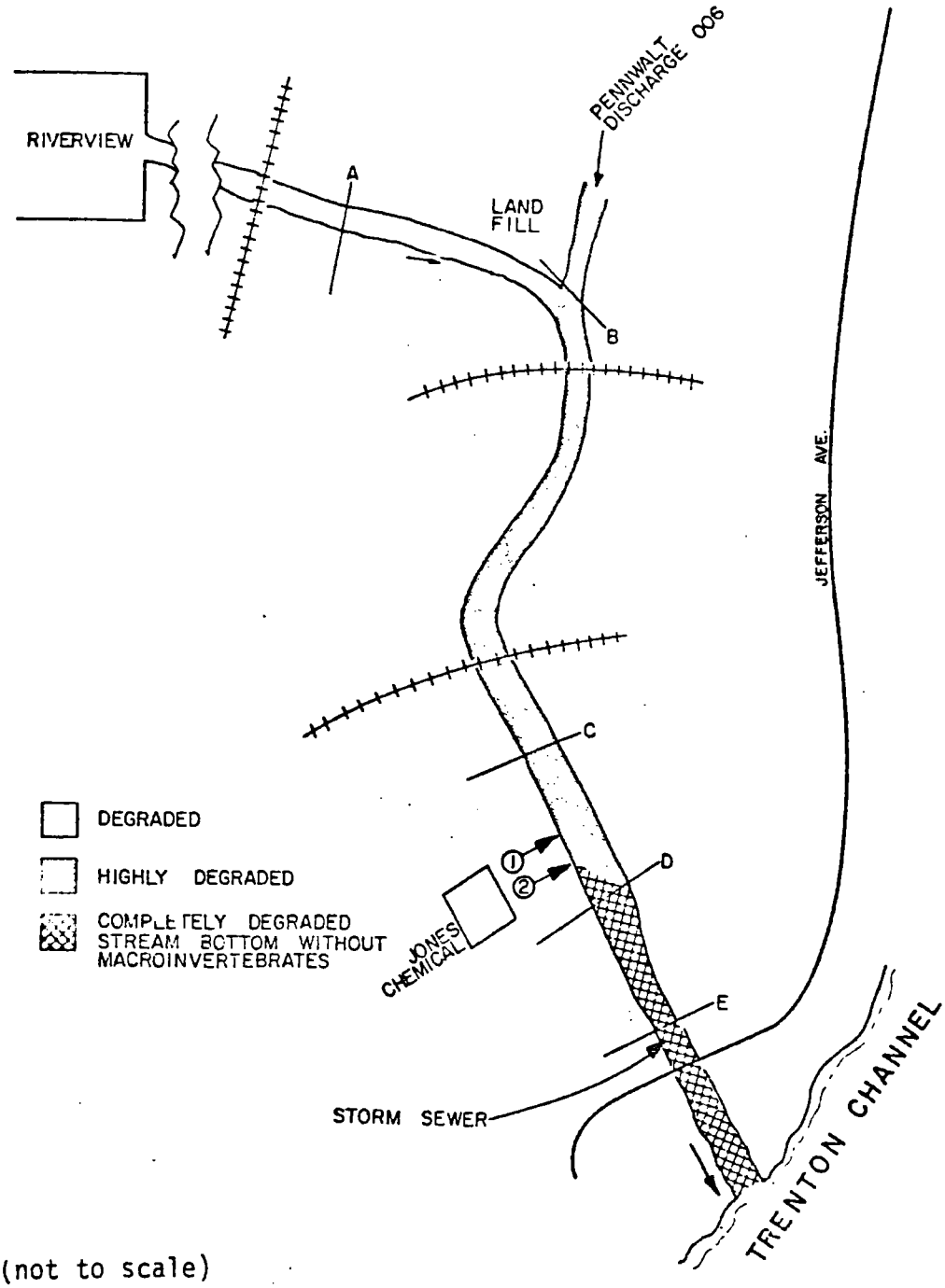
The macroinvertebrate communities of Monguagon Creek indicated a degraded to highly degraded stream condition (Figure 4). Pollution tolerant organisms dominated the macroinvertebrate community in the study area. Oligochaetes or aquatic worms comprised more than 90 percent of all the macroinvertebrates collected both in terms of density and biomass (Appendix VIII). Only at station A were significant numbers of midges (Procladius) collected. This animal feeds on worms but is less tolerant of extreme environmental stress than oligochaetes.

Macroinvertebrate densities decreased from almost 24,000/m^2 at station A to 318/m^2 at station D. No macroinvertebrates were found at station E nor in the three samples closest to the Jones Chemical discharge at station D.

Fish

Only two fish (gizzard shad) were observed in this shallow, open stream. Even this was surprising under the conditions. One dead gizzard shad was found just below the Jones Chemical discharge. Apparently the fish had died recently as deterioration was not evident. The second fish was disoriented and swimming in circles as it moved downstream in the vicinity of station E. Total chlorine at 1.4 mg/l was found at this station and by itself was sufficient to cause

Figure 4. Areas of degradation in Monguagon Creek, Wayne County, Michigan February 20, 1980 based on benthic macroinvertebrate community structure.



death in less than half an hour (Mattice and Zittel, 1976).

SUMMARY AND CONCLUSIONS

Benthic animals communities, or their absence in Monguagon Creek indicated stream conditions that ranged from degraded to completely degraded. Degradation or damage to the benthic communities was associated with high concentrations of sediment contaminants such as oils, toxic heavy metals, cyanide and high concentrations of chlorine in the water. Similar responses of benthic communities to such contaminants have been observed many times before (Mackenthun, 1969). Recently, Wentsel and McIntosh (1977) also found oligochaete dominated benthic communities where heavy metals in lake sediments were extremely high (cadmium-996 mg/kg, zinc-14,033 mg/kg, and chromium-2106 mg/kg) and midge larvae were present only where heavy metals decreased in the sediment. Given the concentrations of sediment contaminants in Monguagon Creek, it is improbable that the elimination of the benthic community downstream of the Jones Chemical discharge was due only to their discharge of heavy metals. The pattern of benthos elimination closely approximated the area of stream bottom impacted by the plume from the Jones Chemical unpermitted discharge with very high concentrations of extremely toxic chlorine. It is therefore very reasonable to conclude that a minimum of 0.15 km of Monguagon Creek has been damaged as a result of the unpermitted Jones Chemical discharge.

Damage to Monguagon Creek undoubtedly also extends for the remaining 0.7 km to its confluence with the Trenton Channel. Sediment contaminants would surely remain at or above concentrations similar to those found downstream of the Pennwalt discharge, as most of these substances do not biodegrade readily and channel erosion processes tend to transport sediments downstream. It is not certain however, that the macroinvertebrate community has been eliminated in this lower stream reach nor could any or all damage be blamed with certainty on the upstream discharges. Storm sewers and runoff from streets, coal piles and the surrounding area would have degrading effects in the lower stream reach. Furthermore, it is not certain whether chlorine concentrations have been at toxic concentrations to the Trenton Channel in the past because chlorine readily reacts and loses its toxicity.

In order to expedite the recovery of Monguagon Creek several actions should be undertaken. A study of Monguagon Creek upstream of the study site and in Riverview should be undertaken to determine the source(s) of stream contaminants. Pennwalt's wastewater treatment should be upgraded to meet NPDES requirements and the Jones Chemical discharges should either be eliminated or adequate treatment be provided to protect Monguagon Creek. In addition, the highly contaminated sediments downstream of Pennwalt and Jones Chemical should be removed, not only to facilitate stream recovery but to prevent their discharge to the Trenton Channel.

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Enfironmental Enforcement Division
Frank Horvath, Aquatic Biologist,
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Elwin Evans, Aquatic Biologist,
Water Quality Division

Report By: Elwin Evans, PhD
Aquatic Biologist
Biology Section
Water Quality Division
Department of Natural Resources

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APPENDIX I

PEAS 205-80

MICHIGAN DEPT. OF NATURAL RESOURCES, ENVIRONMENTAL LABORATORY ANALYSIS -- ENIVRONMENTAL QUALITY - WATER - GENERAL USAGE

LAB LOG# 4566 PROJ CODE 5D COST CENTER ------ FR --- COLLECTED BY [illegible] TRANSFERED TO ---------- RECEIVED AT LAB [illegible] EXAMINER [illegible]

LOCATION SAMPLED Jones Chemical - Riverview SAMPLE REMARKS * High pH - chlorine present SEND RESULTS TO (NAME & SECTION) Bill Stone Dist #1

FIELD ID.	"DO NOT PUNCH" DESCRIPTION OF SAMPLING SITE OR SAMPLE	REF NO. P	STORET NUMBER	START DATE YYMMDD	TIME MIL TTTT	DEPTH IN FEET	LAB NO. 2 00008	TEMP. DEGREE CENT. 00010	OXYGEN DIS. MG/L 00300	PH STAND. UNITS 00400	COND. 25 C US/CM 00095	BOD-5 TOTAL MG/L 00310	C.O.D. LOW MG/L 00335	T.O.C. AMPUL MG/L 00680	NOCNO. TOTAL MG/L 00630
1	upstream - top (surface)	I01		800201	1650		5035			7.7 SC					
2	downstream - top (surface)	I02		800204	1650		5036			7.6 SC					
3	discharge - Bottom	I03		800204	1650		5037			15.75 SC					
4	discharge - top (surface)	I04		800204	1650		5038			11.3 SC					
		I05													
		I06													
		I07													
		I08													
		I09													
		I10													

REF NO.	NO3 TOTAL MG/L N 00620	NO2 TOTAL MG/L N 00615	NH3 TOTAL MG/L N 00610	KJEL N TOTAL MG/L N 00625	ORTH.P TOTAL MG/L P 70507	PHOS. TOTAL MG/L P 00665	CA TOTAL MG/L 00916	MG TOTAL MG/L 00927	NA TOTAL MG/L 00929	K TOTAL MG/L 00937	F TOTAL MG/L 00951	CL TOTAL MG/L 00940	SI REACT. MG/L 00958	S= TOTAL MG/L S 00745	SO4= TOTAL MG/L 00945	ALK. TOTAL MG/L 00410
01	C								24 SC			41 SC			34 SC	
02	C								25 SC			43 SC			35 SC	
03	C								9100 SC			7400 SC			320 SC	
04	C								150 SC			166 SC			43 SC	
05	C															
06	C															
07	C															
08	C															
09	C															
10	C															

FSD 25200 10/79

* these samples are in improper containers because this was an emergency sampling done by a Conservation Officer

APPENDIX II

MICHIGAN DEPT. OF NATURAL RESOURCES, ENVIRONMENTAL LABORATORY ANALYSIS -- INORGANICS -SEDIMENTS -DRY WT. BASIS

LAB LOG# 4512 PROJ CODE ---- COST CENTER ------ PB 3 COLLECTED BY W.E. Stone TRANSFERED TO Wm Murphy RECEIVED AT LAB [illegible] EXAMINER [illegible]

LOCATION SAMPLED Jones Chemical - Riverview SAMPLE REMARKS Kept chilled / Decant H_2O SEND RESULTS TO (NAME & SECTION) Bill Murphy EED

FIELD ID.	"DO NOT PUNCH" DESCRIPTION OF SAMPLING SITE OR SAMPLE	REF NO. P	STORET NUMBER	START DATE YYMMDD	TIME MIL TTTT	S,T OR B	NUM SAM-PLES	END DATE YYMMDD	TIME MIL TTTT	DEP-TH FEET	LAB NO. 2 00008	TOTAL SOLIDS PERCENT 70110	VOLITL SOLIDS % T.S. 70322	CN-SED DRY-WT MG/KG 00721	CD-SED DRY-WT MG/KG 01028	CR-TOT DRY-WT MG/KG 01029
4	implant sump	C01		800214	13:30						5157	71				15
		C02														
		C03														
		C04														
		C05														
		C06														
		C07														
		C08														
		C09														
		C10														

REF NO.	CU-SED DRY-WT MG/KG 01043	FE-SED DRY-WT MG/KG 01170	NI-SED DRY-WT MG/KG 01068	PB-SED DRY-WT MG/KG 01052	ZN-SED DRY-WT MG/KG 01093	MN-SED DRY-WT MG/KG 01053	AS-SED DRY-WT MG/KG 01003	HG-SED DRY-WT MG/KG 71921	SE-SED DRY-WT MG/KG 01148
01	/	280,000		3400	1500				
02									
03									
04									
05									
06									
07									
08									
09									
10									

APPENDIX III

MICHIGAN DEPT. OF NATURAL RESOURCES, ENVIRONMENTAL LABORATORY ANALYSIS -- ENV. QUALITY-WATER - POINT SOURCE STUDIES SEC.

LAB LOG# 4584 PROJ CODE 7E COST CENTER ------ PR 1 COLLECTED BY W.E. Stone TRANSFERED TO Wm. Murphy RECEIVED AT LAB [illegible] EXAMINER [illegible]

LOCATION SAMPLED Jones Chemical Co. - Riverview SAMPLE REMARKS Kept chilled SEND RESULTS TO (NAME & SECTION) Bill Murphy Env. Enf. Div.

"DO NOT PUNCH"

FIELD ID.	DESCRIPTION OF SAMPLING SITE OR SAMPLE	REF NO. P	STORET NUMBER	START DATE YYMMDD	TIME MIL TTTT	S,T OR B	NUM SAMPLES	END DATE YYMMDD	TIME MIL TTTT	DEPTH FEET	LAB NO. 2 00008	TEMP. DEGREE CENT. 00010	PH STAND. UNITS 00400	CL2 RES MG/L 50060	BOD-5 TOTAL MG/L 00310	C.O.D. HIGH MG/L 00340
1	Pipe to Sump	C01		800214	12.15						5159			none		
2	in the outside Sump	C02		"	12.15						5160			high		
3	outfall at Creek	C03		"	12.40						5161			high		
4	" " "	C04		"	12.45						5162			high		
5	" " "	C05		"	12.45						5163			high		
6	" " "	C06		"	12.45						5164			high		
7	from NaOCl Bucket tank	C07		"	13.40						5165			very high		
		C08														
		C09														
		C10														

REF NO.	T.O.C. AMPUL MG/L 00680	NO3NO2 TOTAL MG/L N 00630	NH3 TOTAL MG/L N 00610	ORG N TOTAL MG/L N 00605	PHOS. TOTAL MG/L P 00665	CL TOTAL MG/L 00940	S= TOTAL MG/L S 00745	SO4 TOTAL MG/L 00945	Na 00929
01				C		86.		50	65
02				C		5300.		INT	8000
03				C		1030.		44	1450
04				C		3300.		INT	8300
05				C		2000.		INT	3900
06				C		24100 PS		INT	5900
07				C		148,000		INT	77000
08				C					
09				C					
10				C					

ESD-00302 REV. 10/79

APPENDIX IV

MINNESOTA DEPT. OF NATURAL RESOURCES, ENVIRONMENTAL LAB — ANALYSIS -- PHYSICAL & BIOLOGICAL - WATER - GENERAL USAGE

LAB USE 4504 PROJ CODE 75 COST CENTER ____ PR COLLECTED BY SF DATE ____ TRANSFERED TO Wm. Murphy RECEIVED AT LAB ____ EXAMINER RV

LOCATION COLLECTED Jones Chemical Co. - Riverview SAMPLE REMARKS ____ SEND RESULTS TO (NAME & SECTION) Bill Murphy Env. Enf. Div.

FIELD ID.	"DO NOT PUNCH" DESCRIPTION OF SAMPLING SITE OR SAMPLE	REP NO. F	STORET NUMBER	START DATE YYMMDD	TIME MIL TTTT	DEPTH FEET	LAB NO. 00008	FECAL COLI MF. 31616	TOTAL COLI MF. 31504	RES-NF SS-105 MG/L 00530	RES-TF TDS180 MG/L 70300
8	high Pipe into outside Sump	101		900214	13:55		5160	300000	300000		
9	" " " " "	102		"	14:00		5167	230000	260000		
		103									
		104									
		105									
		106									
		107									
		108									
		109									
		110									

SF ID.																			
01																			
02																			
03																			
04																			
05																			
06																			
07																			
08																			
09																			
10																			

ESD-03300 10/79

APPDNDIX V

Royce E. Smith
Managing Director

Duane R. Egeland
Deputy Managing Director,
Director of Engineering

Chester Wozniak
Assistant Managing Director,
Director of Administration

John E. Breen
Director of Legal Services

John W. Hubert
Director of Finance

Rex McCormick
Deputy Secretary

Wayne County Public Works

900 West Lafayette
Detroit, Michigan
48226

313 224 . 3620

On February 20, 1980, 3:00 p.m. Bill Murphy of the Department of Natural Resources brought in four samples to be tested for residual chlorine. The samples were collected within one half of an hour of analysis.

I tested the samples as numbered below.

#2	0.5	P.P.M. free chlorine 4.3 P.P.M. total chlorine
#3	0.1	P.P.M. free chlorine
#4	9500	P.P.M. free chlorine 9900 P.P.M. total chlorine
#5	0.4	P.P.M. free chlorine 1.4 P.P.M. total chlorine

All samples tested using D.P.D. method of chlorine analysis.

Thomas Shoens, Chemist
Wayne County Public Works

TS/cla

APPENDIX VI

Sediment contaminants in Mc[illegible] (Huntington) Creek, Riverview, Wayne County, Michigan, February 20, 1980. All values in milligrams per kilogram[illegible] dry weight unless otherwise indicated.

	Total Solids %	PCB 1260	Cn	Cd	Cr	Cu	Fe	Ni	Pb	Zn	Mn	As	Hg	Oil
Station A														
0.18 km upstream Pennwalt's Discharge mid channel	61	10.0**	<1	2	25*	50*	25,000**	17	90**	440**	380*	12**	<1	5,500**
Station B														
in Pennwalt's Discharge Channel, mid cnannel	57	26.0**	6**	5	160**	110**	32,000**	120**	420**	2,800**	490*	9**	<1	12,000**
Station C		M												
0.05 km upstream Jone's Chemical Discharge														
J.C. side	55	20.0**	5**	6**	140**	110**	37,000**	90**	690**	340**	570**	18**	<1	10,000**
across stream	32	3.2	5**	10**	230**	130**	29,000**	110**	560**	2,800**	360*	33**	2**	20,000**
Station D														
0.02 km downstream Jone's Chemical Discharge														
J.C. side	49	4.6	8**	6**	160**	130**	33,000**	130**	640**	4,700**	530**	15**	<1	11,000**
across stream	54	8.1	4**	5	160**	110**	31,000**	110**	590**	2,500**	500**	26**	1**	12,000**
Station E														
0.17 downstream Jone's Chemical Discharge mid channel	32	6.1	12**	10**	390**	250**	38,000**	230**	920**	18,000**	560**	20**	1**	12,000**

U.S. EPA 1977 Dredge Spoils Criteria
* moderately polluted
** heavily polluted

APPENDIX VII

April 1977 U.S. EPA Dredged Spoil Disposal Criteria Classification Guidelines for Great Lakes Harbors. Values in mg/kg dry weight, values otherwise noted.

Parameter	Non Polluted	Moderately Polluted	Heavily Polluted
Volatile solids %	<5	5-8	>8
COD	<40,000	40-80,000	>80,000
TKN	<1,000	1,000-2,000	>2,000
Oil & Grease (Hexane Solubles)	<1,000	1,000-2,000	>2,000
Lead	<40	40-60	>60
Zinc	<90	90-200	>200
Ammonia	<75	75-200	>200
Cyanide	<0.10	0.10-0.25	>0.25
Phosphorus	<420	420-650	>650
Iron	<17,000	17,000-25,000	>25,000
Nickel	<20	20-50	>50
Manganese	<300	300-500	>500
Arsenic	<3	3-8	>8
Cadmium	*	*	>6
Chromium	<25	25-75	>75
Barium	<20	20-60	>60
Copper	<25	25-50	>50
Mercury			≥1
Total PCB's **			≥10

* Lower limits not established

** The pollutional status of sediments with total PCB concentrations between 1 and 10 mg/kg dry weight will be determined on a case-by-case basis.

Appendix VIII Estimated numbers and wet weight of benthic macroinvertebrates per square meter from samples collected with a petite ponar (15 x 15 cm) in Monguagon (Hunter) Creek near Riverview, Wayne County, Michigan, February 20, 1980.

Station	A			B			C				
Location	0.18 km upstream Pennwalt Discharge			In Pennwalt's Discharge Channel			0.05 km upstream Jones's Chemical Discharge				
Sample Number	A-1	A-2	A-3	B-1	B-2	B-3	C-1	C-2	C-3	C-4	C-5
Sampling Sediment Characteristics	unconsolidated black organic; detritus			gravel ooze	clay organic	clay organic	organic soft	organic gray	clay soft detritus	clay soft	organic clay
Macroinvertebrate Taxa											
Oligochaetes	3,268	54,825	7,740	17,501	1,331	5,418	5,848	8,428	2,623	1,290	258
wet weight	2.6	67.1	6.7	11.4	1.9	7.4	5.6	5.8	2.0	2.0	0.2
Nematodes		473					43				
wet weight		0.4					0.01				
Chironomids											
Procladius	1,032	3,354	817								
wet weight	0.9	1.0	0.6								
Estimated no./m^2	4,300	58,625	8,557				5,891				
Estimated wet wt./m^2	3.5	68.5	7.3				5.61				
Average no./m^2		23,836			8,084				3,689		
Average wet wt./m^2		26.4			6.9				3.1		
Average organism wet wt.		0.0011			0.0009				0.0008		

Station	D					E		
Location	0.02 km downstream Jone's Chemical Discharge					0.17 km downstream Hone's Chemical Discharge		
Sample Number	D-1	D-2	D-3	D-4	D-5	E-1	E-2	E-3
Sampling Sediment Characteristics	sand organic black	clay sand organic	black fine organic	gray black organic	clay black organic	organic black	organic black detritus	clay gray floc
Macroinvertebrate Taxa								
Oligochaetes	0	0	0	129	1,462	0	0	0
wet weight	0	0	0	0.1	1.6	0	0	0
Estimated no./m^2	0	0	0			0	0	0
Estimated wet wt./m^2	0	0	0			0	0	0
Average no./m^2			318				0	
Average wet wt./m^2			0.3				0	
Average organism wet wt.			0.0009				0	

APPENDIX IX

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
WATER QUALITY DIVISION

BIOLOGY SECTION
STREAM PROBLEM ASSESSMENT

Station Number A Investigator(s) EVANS, HORVATH, MURPHY

Date 2/20/80 TIME 12:30 PHOTOGRAPH NUMBER 11, 12, 13

BODY OF WATER MONGUAGON R. LOCATION RIVERVIEW

COUNTY WAYNE T4S R11E S 5 TWP RIVERVIEW

REASON FOR SURVEY JONES CHEMICAL - PENNWALT DISCHARGE IMPACTS

VICINITY LAND USE: Mostly Forest Mostly Urban Mostly Agriculture Other INDUSTRIAL

AVE. STREAM WIDTH 7 m AVE. STREAM DEPTH 0.5 m VELOCITY <0.1 ms STREAM km 1.2 M

STREAM SHADING: Open Partly Open Shaded STREAM TYPE: Coldwater Warmwater

WATER TEMP. 5 °C AIR TEMP. 6 °C WEATHER: Sunny – Partly Cloudy – Cloudy – Rainy DAM u/s: Yes No ____ km

CHANNELIZED: Yes No CHANNEL EROSION: None — Slight — Moderate — Severe HIGH WATER MARK 0.16 m

SECCHI DISC TRANS: ____ m TURBIDITY: Clear — Slightly Turbid — Turbid — Opaque WATER COLOR ____

WATER ODORS: Normal Sewage Petroleum Chemical Other ____

SURFACE OILS: None Slick Sheen Globs Flecks

SEDIMENT ODORS: Normal Sewage Petroleum Chemical Anaerobic Other ____

SEDIMENT OILS: Absent Slight Moderate Profuse

DEPOSITS: Sludge Sawdust Paperfiber Sand Relict Shells Other TWIGS + LEAVES

ARE THE UNDERSIDES OF STONES WHICH ARE NOT DEEPLY IMBEDDED IN SUBSTRATE BLACK? YES NO NA

SUBSTRATE TYPE	FLOW VELOCITY m/sec	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
BOULDER	>1.2 (>3 fps)	256 mm (10") dia.	
RUBBLE*	>0.6 (>2 fps)	64-256 mm (2.1-10") dia.	
GRAVEL*	>0.3 (>1 fps)	2-64 mm (0.1-2.5") dia.	
SAND	>0.2 (>0.7 fps)	0.06-2.00 mm dia. Gritty texture	5
SILT	>0.12 (>0.4 fps)	0.004-0.006 mm dia.	
MUCK-MUD	<0.12 (<0.4 fps)	black, very find organic	90

*IMBEDDEDNESS: 0 = NONE 1 = 1/3 OR LESS 2 = 2/3 OR MORE

SUBSTRATE TYPE	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
CLAY	Slick texture	
MARL	Grey, shell fragments	
DETRITUS	Sticks, wood, coarse plant materials	5
FIBROUS PEAT	Partially decomposed plant material	
PULPY PEAT	Finely divided plant material, parts indistinguishable	
LOGS & STICKS		

BIOTA:

PHYTOPLANKTON	0	1	2	3	4	SLIMES	0	1	2	3	4
PERIPHYTON	0	1	2	3	4	ZOOPLANKTON	0	1	2	3	4
FILAMENTOUS ALGAE	0	1	2	3	4	MACROINVERTEBRATES	0	1	2	3	4
MACROPHYTES	0	1	2	3	4	FISH	0	1	2	3	4

0 - Absent 1 - Sparse 2 - Moderate 3 - Abundant 4 - Profuse

FISH GAME FISH

ROUGH FISH

FORAGE FISH

AQUATIC PLANTS PERIPHYTON FILAMENTOUS ALGAE

MACROPHYTES

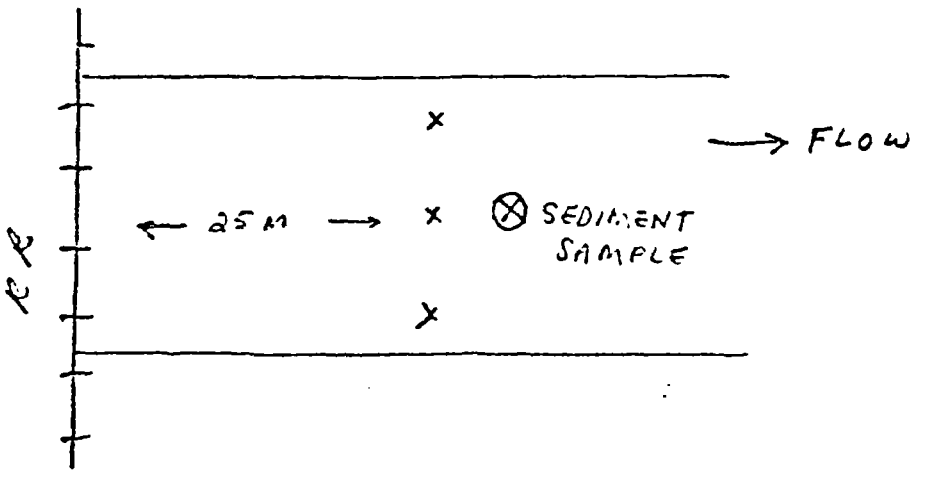
STREAMBANK VEGETATION: GRASSES BRUSH HERBACEOUS CONIFERS DECIDUOUS BARREN OTHER_____

MACROBENTHOS QUALITATIVE SAMPLE CHECK LIST (INDICATE DOMINANT GROUPS)

SPONGES	DRAGONFLIES	RATTAILED MAGGOTS
HYDRA	DAMSELFLIES	MIDGES
FLATWORMS	TRUE BUGS	STONEFLIES
ROUNDWORMS	BEETLES	MAYFLIES
LEECHES	AQUATIC CATTERPILLARS	-BURROWERS
WATER MITES	ALDERFLIES	-SWIMMERS
SOWBUGS	HELLGRAMITES	-CLINGERS, SPRAWLERS
SCUDS	CRANEFLIES	CADDISFLIES
CRAYFISH	NO-SEE-UMS	-FREE LIVING
SNAILS-LIMPETS	BLACKFLIES	-PURSE CASE MAKERS
CLAMS	DEERFLIES	-TUBE CASE MAKERS
AQUATIC EARTHWORMS	MOSQUITOES	-SADDLECASE MAKERS
	SNIPEFLIES	-NET SPINNERS OR RETREATMAKERS

NOTES, ETC.

STATION A



APPENDIX X

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
WATER QUALITY DIVISION

BIOLOGY SECTION
STREAM PROBLEM ASSESSMENT

Station Number B Investigator(s) EVANS, ADKATH, MURPHY

Date 8/20/80 TIME 12:45 PHOTOGRAPH NUMBER 14, 15, 16, 17

BODY OF WATER MONGUAGON CREEK LOCATION RIVERVIEW

COUNTY WAYNE T4S R11E S 5 TWP RIVERVIEW

REASON FOR SURVEY JONES CHEMICAL - PENNWALT DISCHARGE IMPACTS

VICINITY LAND USE: Mostly Forest Mostly Urban Mostly Agriculture Other INDUSTRIAL

AVE. STREAM WIDTH 5 m AVE. STREAM DEPTH 0.3 m VELOCITY >0.12 ms STREAM km 1.20

STREAM SHADING: Open Partly Open Shaded STREAM TYPE: Coldwater Warmwater

WATER TEMP. 11 °C AIR TEMP. 5 °C WEATHER: Sunny – Partly Cloudy – Cloudy – Rainy DAM u/s: Yes No ____ km

CHANNELIZED: Yes No CHANNEL EROSION: None — Slight — Moderate — Severe HIGH WATER MARK 0.16 m

SECCHI DISC TRANS: ____ m TURBIDITY: Clear — Slightly Turbid — Turbid — Opaque WATER COLOR ____

WATER ODORS: Normal Sewage Petroleum Chemical Other ____

SURFACE OILS: None Slick Sheen Globs Flecks

SEDIMENT ODORS: Normal Sewage Petroleum Chemical Anaerobic Other ____

SEDIMENT OILS: Absent Slight Moderate Profuse

DEPOSITS: Sludge Sawdust Paperfiber Sand Relict Shells Other ____

ARE THE UNDERSIDES OF STONES WHICH ARE NOT DEEPLY IMBEDDED IN SUBSTRATE BLACK? YES NO NA

SUBSTRATE TYPE	FLOW VELOCITY m/sec	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
BOULDERS*	>1.2 (>3 fps)	256 mm (10") dia.	
RUBBLE*	>0.6 (>2 fps)	64-256 mm (2.1-10") dia.	
GRAVEL*	>0.3 (>1 fps)	2-64 mm (0.1-2.5") dia.	
SAND	>0.2 (>0.7 fps)	0.06-2.00 mm dia. Gritty texture	50
SILT	>0.12 (>0.4 fps)	0.004-0.006 mm dia.	
MUCK-MUD	<0.12 (<0.4 fps)	black, very find organic	50

*IMBEDDEDNESS: 0 = NONE 1 = 1/3 OR LESS 2 = 2/3 OR MORE

SUBSTRATE TYPE	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
CLAY	Slick texture	
MARL	Grey, shell fragments	
DETRITUS	Sticks, wood, coarse plant materials	
FIBROUS PEAT	Partially decomposed plant material	
PULPY PEAT	Finely divided plant material, parts indistinguishable	
LOGS & STICKS		

BIOTA:

PHYTOPLANKTON	0	1	2	3	4	SLIMES	0	1	2	3	4
PERIPHYTON	0	1	2	3	4	ZOOPLANKTON	0	1	2	3	4
FILAMENTOUS ALGAE	0	1	2	3	4	MACROINVERTEBRATES	0	1	2	3	4
MACROPHYTES	0	1	2	3	4	FISH	0	1	2	3	4

0 - Absent 1 - Sparse 2 - Moderate 3 - Abundant 4 - Profuse

FISH GAME FISH

ROUGH FISH

FORAGE FISH

AQUATIC PLANTS PERIPHYTON FILAMENTOUS ALGAE

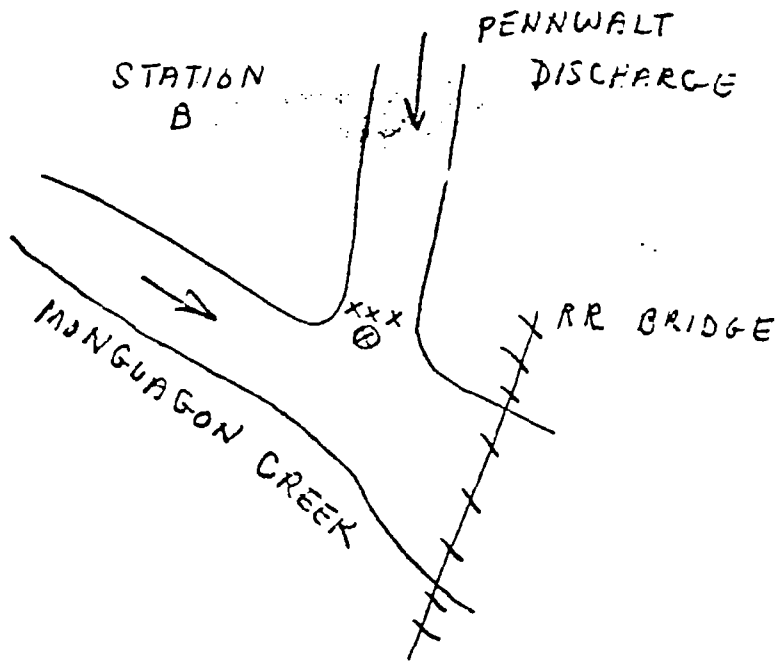
MACROPHYTES

STREAMBANK VEGETATION: GRASSES BRUSH HERBACEOUS CONIFERS DECIDUOUS BARREN OTHER _____

MACROBENTHOS QUALITATIVE SAMPLE CHECK LIST (INDICATE DOMINANT GROUPS)

SPONGES	DRAGONFLIES	RATTAILED MAGGOTS
HYDRA	DAMSELFLIES	MIDGES
FLATWORMS	TRUE BUGS	STONEFLIES
ROUNDWORMS	BEETLES	MAYFLIES
LEECHES	AQUATIC CATTERPILLARS	-BURROWERS
WATER MITES	ALDERFLIES	-SWIMMERS
SOWBUGS	HELLGRAMITES	-CLINGERS, SPRAWLERS
SCUDS	CRANEFLIES	CADDISFLIES
CRAYFISH	NO-SEE-UMS	-FREE LIVING
SNAILS-LIMPETS	BLACKFLIES	-PURSE CASE MAKERS
	DEERFLIES	-TUBE CASE MAKERS
	MOSQUITOES	-SADDLECASE MAKERS
	SNIPEFLIES	-NET SPINNERS OR RETREATMAKERS

NOTES, ETC.



APPENDIX XI

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
WATER QUALITY DIVISION

BIOLOGY SECTION
STREAM PROBLEM ASSESSMENT

Station Number C Investigator(s) EVANS, HORVATH

Date 2/20/80 TIME 13:15 PHOTOGRAPH NUMBER 18, 19, 20

BODY OF WATER MONGUAGON CREEK LOCATION RIVERVIEW

COUNTY WAYNE T4S R11E S 5 TWP RIVERVIEW

REASON FOR SURVEY JONES CHEMICAL - PENNWALT DISCHARGE IMPACTS

VICINITY LAND USE: Mostly Forest Mostly Urban Mostly Agriculture Other INDUSTRIAL

AVE. STREAM WIDTH 20 m AVE. STREAM DEPTH 0.3 m VELOCITY 0.12 m/s STREAM km 0.75

STREAM SHADING: Open Partly Open Shaded STREAM TYPE: Coldwater Warmwater

WATER TEMP. 7.7 °C AIR TEMP. 5 °C WEATHER: Sunny – Partly Cloudy – Cloudy – Rainy DAM u/s: Yes No ____ km

CHANNELIZED: Yes No CHANNEL EROSION: None — Slight — Moderate — Severe HIGH WATER MARK 0.15 m

SECCHI DISC TRANS: ____ m TURBIDITY: Clear — Slightly Turbid — Turbid — Opaque WATER COLOR ____

WATER ODORS: Normal Sewage Petroleum Chemical Other ____

SURFACE OILS: None Slick Sheen Globs Flecks

SEDIMENT ODORS: Normal Sewage Petroleum Chemical Anaerobic Other ____

SEDIMENT OILS: Absent Slight Moderate Profuse

DEPOSITS: Sludge Sawdust Paperfiber Sand Relict Shells Other ____

ARE THE UNDERSIDES OF STONES WHICH ARE NOT DEEPLY IMBEDDED IN SUBSTRATE BLACK? YES NO NA

SUBSTRATE TYPE	FLOW VELOCITY m/sec	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
BOULDER*	>1.2 (>3 fps)	256 mm (10") dia.	
RUBBLE*	>0.6 (>2 fps)	64-256 mm (2.1-10") dia.	
GRAVEL*	>0.3 (>1 fps)	2-64 mm (0.1-2.5") dia.	
SAND	>0.2 (>0.7 fps)	0.06-2.00 mm dia. Gritty texture	
SILT	>0.12 (>0.4 fps)	0.004-0.006 mm dia.	
MUCK-MUD	<0.12 (<0.4 fps)	black, very find organic	95

*IMBEDDEDNESS: 0 = NONE 1 = 1/3 OR LESS 2 = 2/3 OR MORE

SUBSTRATE TYPE	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
CLAY	Slick texture	
MARL	Grey, shell fragments	
DETRITUS	Sticks, wood, coarse plant materials	5
FIBROUS PEAT	Partially decomposed plant material	
PULPY PEAT	Finely divided plant material, parts indistinguishable	
LOGS & STICKS		

BIOTA:

PHYTOPLANKTON	0	1	2	3	4	SLIMES	0	1	2	3	4
PERIPHYTON	0	1	2	3	4	ZOOPLANKTON	0	1	2	3	4
FILAMENTOUS ALGAE	0	1	2	3	4	MACROINVERTEBRATES	0	1	2	3	4
MACROPHYTES	0	1	2	3	4	FISH	0	1	2	3	4

0 - Absent 1 - Sparse 2 - Moderate 3 - Abundant 4 - Profuse

FISH GAME FISH

ROUGH FISH

FORAGE FISH

AQUATIC PLANTS PERIPHYTON FILAMENTOUS ALGAE

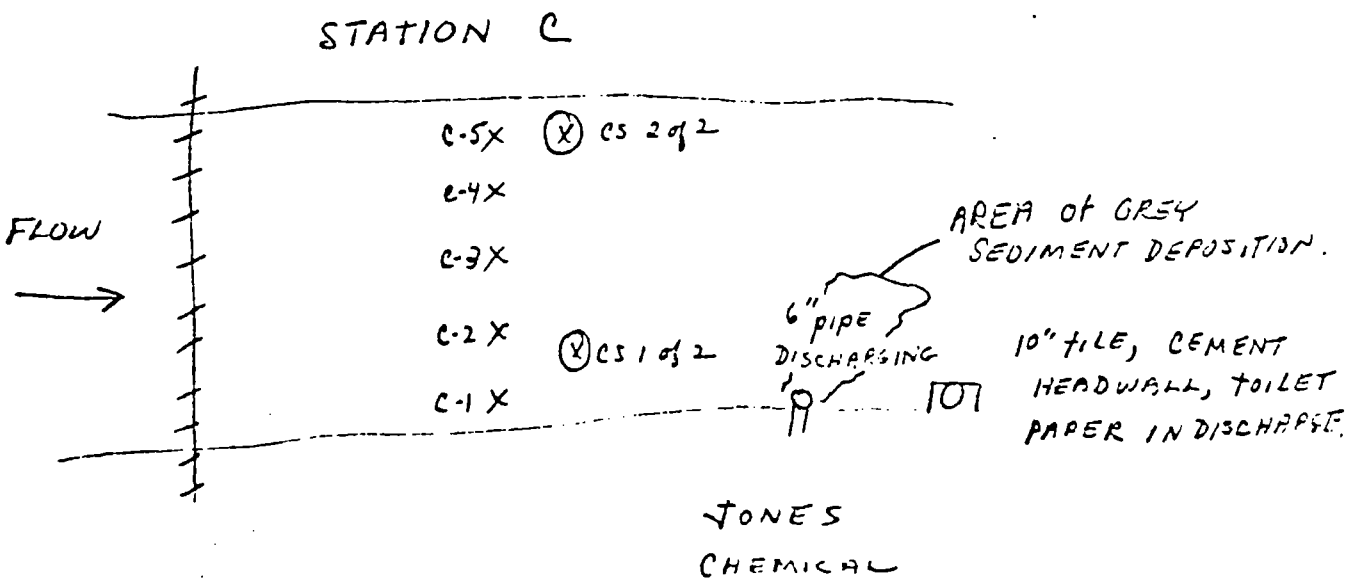
MACROPHYTES

STREAMBANK VEGETATION: GRASSES BRUSH HERBACEOUS CONIFERS DECIDUOUS BARREN OTHER_____

MACROBENTHOS QUALITATIVE SAMPLE CHECK LIST (INDICATE DOMINANT GROUPS)

SPONGES	DRAGONFLIES	RATTAILED MAGGOTS
HYDRA	DAMSELFLIES	MIDGES
FLATWORMS	TRUE BUGS	STONEFLIES
ROUNDWORMS	BEETLES	MAYFLIES
LEECHES	AQUATIC CATTERPILLARS	-BURROWERS
WATER MITES	ALDERFLIES	-SWIMMERS
SOWBUGS	HELLGRAMITES	-CLINGERS, SPRAWLERS
SCUDS	CRANEFLIES	CADDISFLIES
CRAYFISH	NO-SEE-UMS	-FREE LIVING
SNAILS-LIMPETS	BLACKFLIES	-PURSE CASE MAKERS
	DEERFLIES	-TUBE CASE MAKERS
	MOSQUITOES	-SADDLECASE MAKERS
	SNIPEFLIES	-NET SPINNERS OR RETREATMAKERS

~LAST SHOTS ON FILM RUINED.



APPENDIX XII

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
WATER QUALITY DIVISION

BIOLOGY SECTION
STREAM PROBLEM ASSESSMENT

Station Number D Investigator(s) EVANS, HORVATH

Date 2/20/87 TIME 13:45 PHOTOGRAPH NUMBER —

BODY OF WATER MONGUAGON CREEK LOCATION RIVERVIEW

COUNTY WAYNE TYSP/RIES 5 TWP RIVERVIEW

REASON FOR SURVEY JONES CHEMICAL - PENNWALT DISCHARGE IMPACT

VICINITY LAND USE: Mostly Forest Mostly Urban Mostly Agriculture Other INDUSTRIAL

AVE. STREAM WIDTH 20 m AVE. STREAM DEPTH 0.3 m VELOCITY 0.12 ms STREAM km 0.68

STREAM SHADING: Open Partly Open Shaded STREAM TYPE: Coldwater Warmwater

WATER TEMP. 7.7 °C AIR TEMP. 5 °C WEATHER: Sunny – Partly Cloudy – Cloudy – Rainy DAM u/s: Yes No ____ km

CHANNELIZED: Yes No CHANNEL EROSION: None — Slight — Moderate — Severe HIGH WATER MARK 0.15 m

SECCHI DISC TRANS: ____ m TURBIDITY: Clear — Slightly Turbid — Turbid — Opaque WATER COLOR ____

WATER ODORS: Normal Sewage Petroleum Chemical Other ____

SURFACE OILS: None Slick Sheen Globs Flecks

SEDIMENT ODORS: Normal Sewage Petroleum Chemical Anaerobic Other ____

SEDIMENT OILS: Absent Slight Moderate Profuse

DEPOSITS: Sludge Sawdust Paperfiber Sand Relict Shells Other ____

ARE THE UNDERSIDES OF STONES WHICH ARE NOT DEEPLY IMBEDDED IN SUBSTRATE BLACK? YES NO NA

SUBSTRATE TYPE	FLOW VELOCITY m/sec	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
BOULDERS*	>1.2 (>3 fps)	256 mm (10") dia.	
RUBBLE*	>0.6 (>2 fps)	64-256 mm (2.1-10") dia.	
GRAVEL*	>0.3 (>1 fps)	2-64 mm (0.1-2.5") dia.	
SAND	>0.2 (>0.7 fps)	0.06-2.00 mm dia. Gritty texture	
SILT	>0.12 (>0.4 fps)	0.004-0.006 mm dia.	
MUCK-MUD	>0.12 (>0.4 fps)	black, very find organic	95

*IMBEDDEDNESS: 0 = NONE 1 = 1/3 OR LESS 2 = 2/3 OR MORE

SUBSTRATE TYPE	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
CLAY	Slick texture	
MARL	Grey, shell fragments	
DETRITUS	Sticks, wood, coarse plant materials	5
FIBROUS PEAT	Partially decomposed plant material	
PULPY PEAT	Finely divided plant material, parts indistinguishable	
LOGS & STICKS		

BIOTA:

PHYTOPLANKTON	0	1	2	3	4	SLIMES	0	1	2	3	4
PERIPHYTON	0	1	2	3	4	ZOOPLANKTON	0	1	2	3	4
FILAMENTOUS ALGAE	0	1	2	3	4	MACROINVERTEBRATES	0	1	2	3	4
MACROPHYTES	0	1	2	3	4	FISH	0	1	2	3	4

0 - Absent 1 - Sparse 2 - Moderate 3 - Abundant 4 - Profuse

FISH — GAME FISH, ROUGH FISH, FORAGE FISH: SHAD ONE GIZZARD, 12-15"; UNDER STRESS, SWIMMING IN CIRCLES NEAR THE SURFACE.

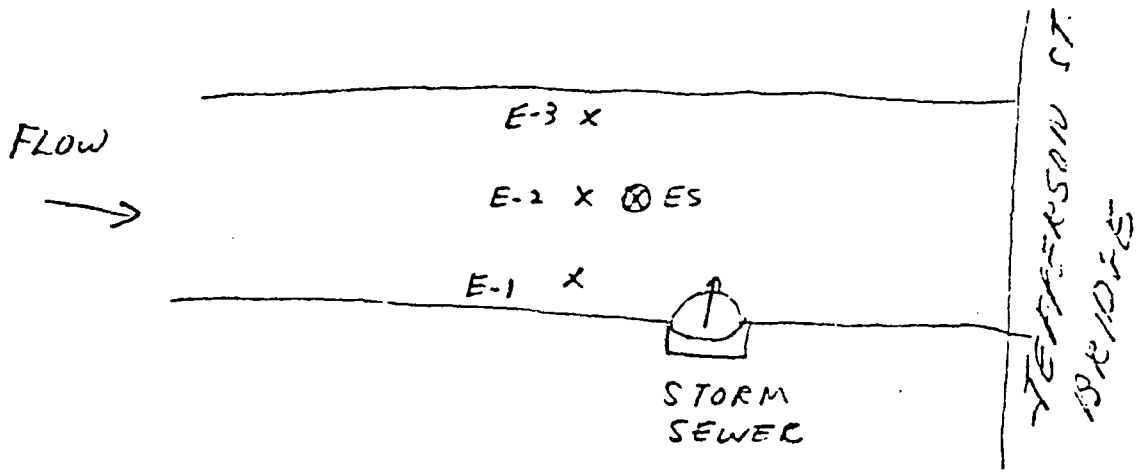
AQUATIC PLANTS — PERIPHYTON — FILAMENTOUS ALGAE

MACROPHYTES

STREAMBANK VEGETATION: GRASSES BRUSH HERBACEOUS CONIFERS DECIDUOUS BARREN OTHER

MACROBENTHOS QUALITATIVE SAMPLE CHECK LIST (INDICATE DOMINANT GROUPS)

SPONGES	DRAGONFLIES	RATTAILED MAGGOTS
HYDRA	DAMSELFLIES	MIDGES
FLATWORMS	TRUE BUGS	STONEFLIES
ROUNDWORMS	BEETLES	MAYFLIES
LEECHES	AQUATIC CATTERPILLARS	-BURROWERS
WATER MITES	ALDERFLIES	-SWIMMERS
SOWBUGS	HELLGRAMITES	-CLINGERS, SPRAWLERS
SCUDS	CRANEFLIES	CADDISFLIES
CRAYF	NO-SEE-UMS	-FREE LIVING
SNA	BLACKFLIES	-PURSE CASE MAKERS
CL	DEERFLIES	-TUBE CASE MAKERS
A	MOSQUITOES	-SADDLECASE MAKERS
	SNIPEFLIES	-NET SPINNERS OR RETREATMAKERS



APPENDIX XIII

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
WATER QUALITY DIVISION

BIOLOGY SECTION
STREAM PROBLEM ASSESSMENT

Station Number E Investigator(s) EVANS, HORLATH

Date 2/22/80 TIME 14:15 PHOTOGRAPH NUMBER ____

BODY OF WATER MONGUAGON CREEK LOCATION RIVERVIEW

COUNTY WAYNE T4E R11S 5 TWP. RIVERVIEW

REASON FOR SURVEY JONES CHEMICAL - PENNWALT DISCHARGE IMPACTS

VICINITY LAND USE: Mostly Forest Mostly Urban Mostly Agriculture Other INDUSTRIAL

AVE. STREAM WIDTH 13 m AVE. STREAM DEPTH 0.4 m VELOCITY 0.12 ms STREAM km 0.53

STREAM SHADING: Open Partly Open Shaded STREAM TYPE: Coldwater Warmwater

WATER TEMP. 7.7 °C AIR TEMP. 5.6 °C WEATHER: Sunny – Partly Cloudy – Cloudy – Rainy DAM u/s: Yes No ____ km

CHANNELIZED: Yes No CHANNEL EROSION: None — Slight — Moderate — Severe HIGH WATER MARK 0.15 m

SECCHI DISC TRANS: ____ m TURBIDITY: Clear — Slightly Turbid — Turbid — Opaque WATER COLOR ____

WATER ODORS: Normal Sewage Petroleum Chemical Other ____

SURFACE OILS: None Slick Sheen Globs Flecks

SEDIMENT ODORS: Normal Sewage Petroleum Chemical Anaerobic Other ____

SEDIMENT OILS: Absent Slight Moderate Profuse

DEPOSITS: Sludge Sawdust Paperfiber Sand Relict Shells Other ____

ARE THE UNDERSIDES OF STONES WHICH ARE NOT DEEPLY IMBEDDED IN SUBSTRATE BLACK? YES NO N/A

SUBSTRATE TYPE	FLOW VELOCITY m/sec	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
BOULDERS*	>1.2 (>3 fps)	256 mm (10") dia.	
RUBBLE*	>0.6 (>2 fps)	64-256 mm (2.1-10") dia.	
GRAVEL*	>0.3 (>1 fps)	2-64 mm (0.1-2.5") dia.	
SAND	>0.2 (>0.7 fps)	0.06-2.00 mm dia. Gritty texture	
SILT	>0.12 (>0.4 fps)	0.004-0.006 mm dia.	5
MUCK-MUD	>0.12 (>0.4 fps)	Black, very find organic	90

*IMBEDDEDNESS: 0 = NONE 1 = 1/3 OR LESS 2 = 2/3 OR MORE

SUBSTRATE TYPE	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
CLAY	Slick texture	
MARL	Grey, shell fragments	
DETRITUS	Sticks, wood, coarse plant materials	5
FIBROUS PEAT	Partially decomposed plant material	
PULPY PEAT	Finely divided plant material, parts indistinguishable	
LOGS & STICKS		

BIOTA:

PHYTOPLANKTON	0	1	2	3	4	SLIMES	0	1	2	3	4
PERIPHYTON	0	1	2	3	4	ZOOPLANKTON	0	1	2	3	4
FILAMENTOUS ALGAE	0	1	2	3	4	MACROINVERTEBRATES	0	1	2	3	4
MACROPHYTES	0	1	2	3	4	FISH	0	1	2	3	4

0 - Absent 1 - Sparse 2 - Moderate 3 - Abundant 4 - Profuse

FISH GAME FISH
ROUGH FISH
FORAGE FISH ONE DEAD SHAD SAID BELOW OUTFALL, NOT BOTTOM.

AQUATIC PLANTS PERIPHYTON FILAMENTOUS ALGAE

MACROPHYTES

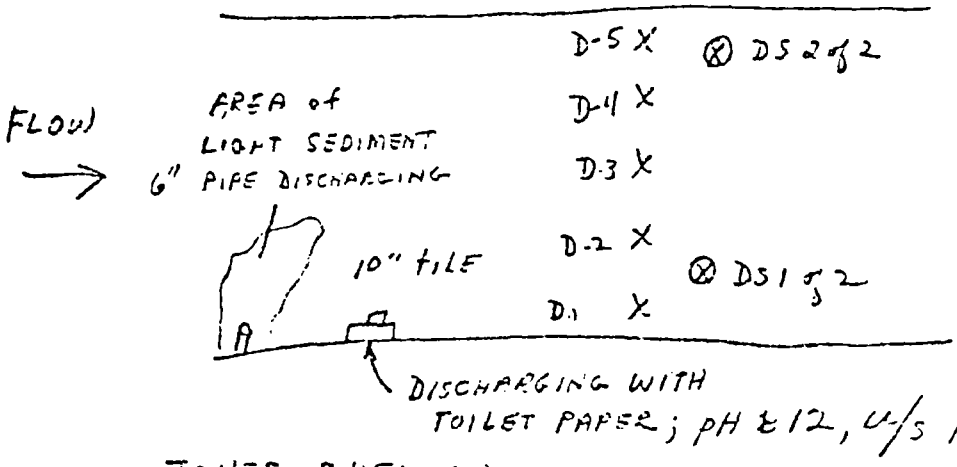
STREAMBANK VEGETATION: GRASSES BRUSH HERBACEOUS CONIFERS DECIDUOUS BARREN OTHER

MACROBENTHOS QUALITATIVE SAMPLE CHECK LIST (INDICATE DOMINANT GROUPS)

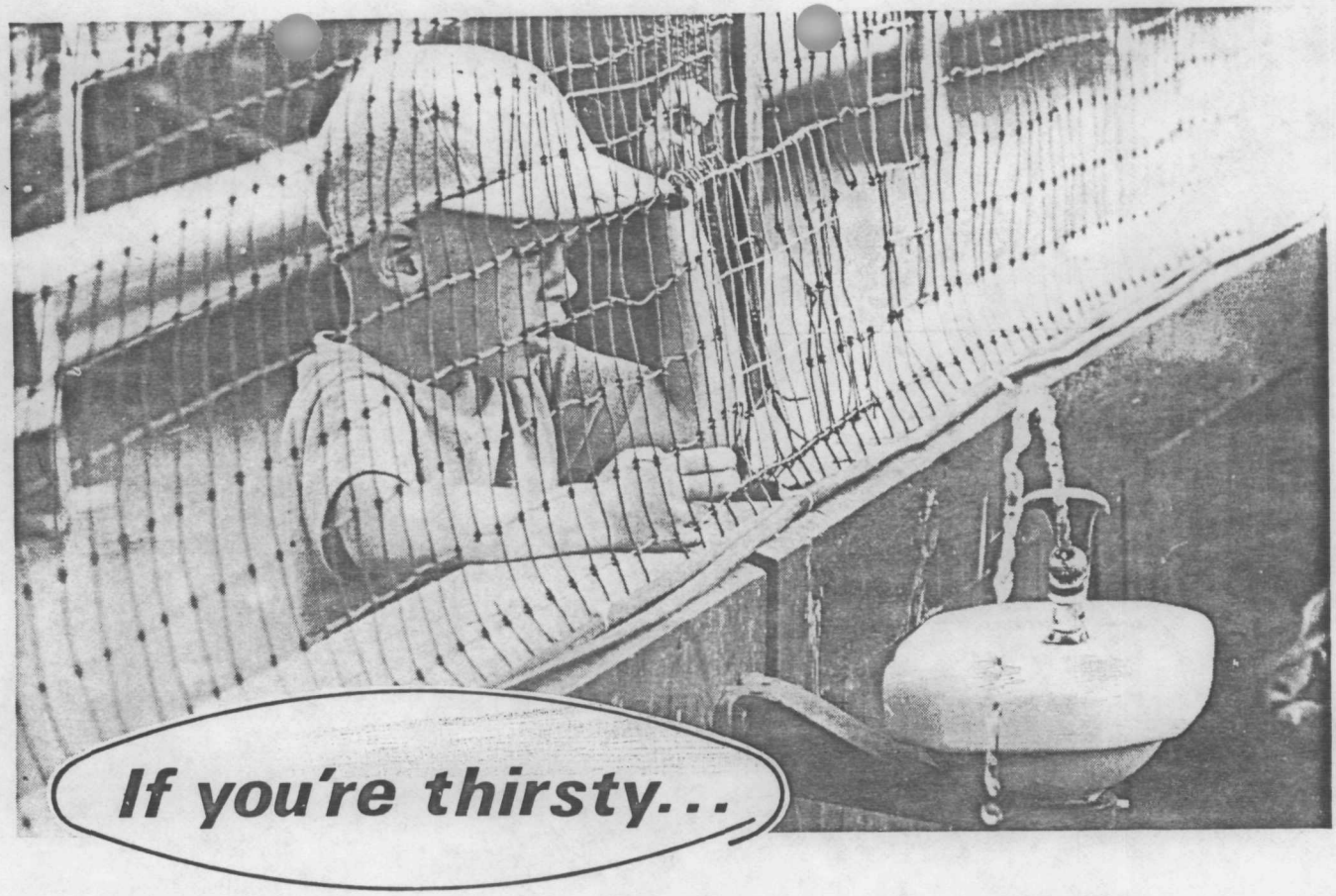
SPONGES	DRAGONFLIES	RATTAILED MAGGOTS
HYDRA	DAMSELFLIES	MIDGES
FLATWORMS	TRUE BUGS	STONEFLIES
ROUNDWORMS	BEETLES	MAYFLIES
LEECHES	AQUATIC CATTERPILLARS	-BURROWERS
WATER MITES	ALDERFLIES	-SWIMMERS
SOW	HELLGRAMITES	-CLINGERS, SPRAWLERS
	CRANEFLIES	CADDISFLIES
	NO-SEE-UMS	-FREE LIVING
	BLACKFLIES	-PURSE CASE MAKERS
	DEERFLIES	-TUBE CASE MAKERS
AQUATIC EARTHWORMS	MOSQUITOES	-SADDLECASE MAKERS
	SNIPEFLIES	-NET SPINNERS OR RETREATMAKERS

NOTES, ETC.

STATION D



JONES CHEMICAL



for land-ownership information, deal with the professionals.

We have a staff of 50, have been in the business of mapping land for 35 years, principally in the Midwest serving clients in 16 states and over 550 counties, including Pennsylvania and now FLORIDA.

. . .and we'd like to be of service to you - whether you're in the business of banking, farming, real estate, insurance, land development, practicing conservation, obtaining leases for minerals, land or right-of-ways, buying or selling. Our plat book coverage will be an aid to you in your business. In handy to use 8½ x 11 size, each book shows by township:

Landowners, acreage (actual shape of parcels)
Farmsteads, natural features (rivers, lakes, streams)
Cultural features (railroads, highways, & roads)

These maps are based on aerial surveys of the land and courthouse records, and compiled by experienced personnel - to make them as accurate as possible. Even a computerized alphabetical index to owners that shows landowners name, section and page.

Of prime importance, of course, is the fact that there is just so much land and it is constantly changing hands - for farming, development either for living purposes, recreation, research, conservation, etc.

We at Rockford Map Publishers are ready to help acquaint you with our unique and informative county by county plat books. Write or call for a complete list of counties available.

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GENERAL HIGHWAY MAP
WAYNE COUNTY
MICHIGAN
STATE HIGHWAY COMMISSION
DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION
DATA OBTAINED FROM
HIGHWAY PLANNING SURVEY
CONDUCTED IN COOPERATION WITH
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
SEE PAGE 108 FOR LEGEND
KEY TO COUNTIES
OAKLAND CO.
MACOMB CO.
WASHTENAW CO.
MONROE CO.
NORTHVILLE
PLYMOUTH
CANTON
VAN BUREN
SUMPTER
HURON
BROWNSTOWN
LIVONIA
REDFORD
DETROIT
DEARBORN
DEARBORN HEIGHTS
GARDEN CITY
WESTLAND
WAYNE
INKSTER
ROMULUS
TAYLOR
ALLEN PARK
MELVINDALE
LINCOLN PARK
RIVER ROUGE
ECORSE
WYANDOTTE
SOUTHGATE
RIVERVIEW
TRENTON
WOODHAVEN
FLAT ROCK
GIBRALTAR
ROCKWOOD
SOUTH ROCKWOOD
GROSSE ILE
BELLEVILLE
NEW BOSTON
WILLOW
WALTZ
WEST SUMPTER
MARTINSVILLE
SHELDON
DENTON
HIGHLAND PARK
HAMTRAMCK
HARPER WOODS
GROSSE POINTE WOODS
GROSSE POINTE SHORES
GROSSE POINTE FARMS
GROSSE POINTE
GROSSE POINTE PARK
NOVI
FARMINGTON HILLS
FARMINGTON
SOUTHFIELD
OAK PARK
FERNDALE
HAZEL PARK
WARREN
EAST DETROIT
ST. CLAIR SHORES
LAKE ST. CLAIR
LAKE ERIE
DETROIT RIVER
AMBASSADOR BRIDGE
DETROIT-WINDSOR AUTO TUNNEL

MICHIGAN HARBORS

	WATERWAY OUTLETS	TRANSIENT ACCOMMODATIONS	SEASONALLY TRANSIENT ACCOMMODATIONS ONLY	GASOLINE	TELEPHONE	WATER	ELECTRICITY	RESTROOMS	SHOWER FACILITIES	DOCK ATTENDANT	HAUL-OUT FACILITIES	HOLDING TANK PUMP-OUT	VHF-FM RADIO
BOLLES HARBOR	Lake Erie	X		X	X	X	X	X			X		
DETROIT MEMORIAL PK.	Detroit River					X	X	X	X	X		X	
WYANDOTTE	Detroit River	X			X	X	X	X					
METROPOLITAN BEACH	Lake St. Clair				X	X	X	X	X			X	
ST. CLAIR	St. Clair River	X		X	X	X	X	X	X	X		X	
PORT HURON	Lake Huron	X		X	X	X	X	X	X	X		X	
PORT SANILAC	Lake Huron	X		X	X	X	X	X	X	X	X	X	X
HARBOR BEACH	Lake Huron	X				X	X			X		X	
PORT AUSTIN	Lake Huron	X		X	X	X	X	X	X	X	X	X	X
CASEVILLE	Lake Huron	X		X	X	X	X	X	X	X		X	
AU GRES HARBOR	Lake Huron	X		X	X	X	X	X	X	X		X	X
EAST TAWAS	Lake Huron	X		X	X	X	X	X		X		X	X
HARRISVILLE	Lake Huron	X		X	X	X	X	X	X	X		X	
ALPENA MOORING FAC.	Lake Huron	X		X	X	X	X	X	X	X	X	X	X
ROGERS CITY	Lake Huron	X		X	X	X	X	X	X	X		X	
HAMMOND BAY	Lake Huron	X		X	X	X	X	X	X	X		X	X
CHEBOYGAN	Lake Huron	X		X	X	X	X	X			X	X	
CHEBOYGAN LOCK	Cheboygan Inl.				X					X			
BOIS BLANC	Lake Huron	X											
MACKINAC ISLAND	Lake Huron	X		X	X	X	X	X	X	X		X	X
MACKINAW CITY	Lake Huron	X		X	X	X	X	X	X	X	X	X	X
BEAVER ISLAND	Lake Michigan	X		X	X	X	X	X		X		X	X
HARBOR SPRINGS	Lake Michigan	X		X	X	X	X	X	X	X	X	X	X
PETOSKEY	Lake Michigan	X		X	X	X	X	X	X	X		X	X
CHARLEVOIX	Lake Michigan	X		X	X	X	X	X	X	X	X	X	X
BOYNE CITY	Lake Michigan	X		X	X	X	X	X				X	
EAST JORDAN	Lake Michigan					X	X				X		
ELK RAPIDS	Lake Michigan	X		X	X	X	X	X	X	X		X	
TRAVERSE CITY	Lake Michigan	X		X	X	X	X	X	X	X		X	
GREILICKVILLE	Lake Michigan		X	X	X	X	X	X		X	X		
SUTTONS BAY	Lake Michigan	X		X	X	X	X						
NORTHPORT	Lake Michigan	X		X	X	X	X	X	X	X		X	X

BOAT LAUNCHING IN MICHIGAN

MICHIGAN'S BOAT LAUNCHING RAMP PROGRAM

Welcome to boating in Michigan!

Michigan residents and visitors are truly in a Water Wonderland. This state has over 11,000 lakes, over 36,000 miles of rivers and streams, and over 3,000 miles of Great Lakes shoreline. Michigan is the only state which touches four of the five Great Lakes.

These waters provide recreational opportunities for sportsmen and boating enthusiasts, who own and register over 500,000 boats. Registrations are expected to increase to 760,000 by 1980. These boaters will need ever increasing numbers of launching sites, to provide public access to Michigan's waters.

In 1939, the state legislature first earmarked funds from increased fishing license fees to purchase water frontage. Acquisition and development have continued to the present day. Now, however, boat license fees and the marine fuel tax support these activities and nearly 1,000 launching sites have been equipped for boaters. Most of these sites are operated by the various divisions of the Department of Natural Resources. Others, owned and operated by local communities, were built under a grant-in-aid agreement, with the state's Waterways Fund providing up to 90% of development costs.

Some boat launching facilities, particularly those in heavily populated areas, receive so much use that entry fees are collected to pay for attendants to keep the sites in order and properly maintained. Fees are also charged for general entry to State Parks and Recreation Areas in the form of annual or daily vehicle permits. Modest fees are charged at some community-owned sites to help pay for operation of the facilities. In general, however, most launching sites may be used free.

BOATING SAFETY TIPS

For safe and pleasurable boating, the Department of Natural Resources' Law Division offers the following safe boating tips:

1. Make sure your boat is properly registered and equipped for safety each time before you start out onto the water.
2. Sharp high-speed turns and other reckless boating cause serious accidents.
3. Learn the basic "Rules of the Road" on water, including proper methods of crossing, meeting, and passing.
4. Life preservers aren't much good unless you use them.
5. Standing in a boat can get you wet.
6. Watch the weather – it will always give you a warning!
7. Watch your boat's wake – you are legally responsible for it.
8. Give the other guy a chance – stay at least 100 feet away from docks, rafts, anchored and moored boats, swimmers and diver's flags – even farther if you are towing waterskiers.
9. Overloading your boat with too large a motor, too many people or too much weight is the first step to disaster.
10. Riding on the bow or gunwale of your boat is dangerous and illegal.

USING THIS DIRECTORY

This boat launching ramp directory is designed to aid users of trailer-borne boats, car-top boats, and canoes in locating places to launch their craft. It also lists information concerning each launch ramp and related facilities, such as parking, toilets, etc. It should be used with a state highway map as a guide.

The directory includes ramps on inland lakes, rivers and streams, and the Great Lakes. Ramps may be within metropolitan areas or up to 30 miles from the nearest town.

Using the information provided, a boater can choose a launching location based on a desired geographical area, an urge to explore new waters, the size of the lake, or the quality of the boat ramp itself.

EXPLANATION OF COLUMN HEADINGS

MAP NUMBER–This number refers to the location of the public access site on the appropriate map near the tables of information.

SITE/WATER–Most access sites have names. They usually are the same as the name of the lake or other body of water which they serve, but in some cases they are named in honor of prominent persons or physical landmarks. The name of the water is also given.

WATER ACRES–Surface area, in acres, of the inland lake or impoundment. N/A means Not Applicable and indicates sites on the Great Lakes, rivers and streams. CANOES indicates streams that are suitable only for canoeing, because of stream size or legislation.

NEAREST TOWN–Using a Michigan state highway map, this will be the town nearest the facility. In some cases, this will be in an adjacent county. In many cases, you will have to ask directions from the local townspeople to find the access site. Also, watch for Department of Natural Resources signs indicating turns and distances to access sites.

RAMP CODE–This number tells what type of launching ramp the site user can expect to find at the access site. The numbers mean:

1 – A hard surfaced ramp with sufficient water depth to accommodate all trailerable watercraft. (Minimum water depth of 2½ feet at 20 feet out from shore.)

2 – A hard-surfaced ramp, in areas of limited water depth, where launching and retrieving of largest watercraft may be difficult.

3 – A gravel surfaced ramp, suitable for medium-sized and smaller boats only.

4 – A launching area suitable for car-top boats and canoes only.

TOILETS–"Yes" indicates a public toilet is either at or near the access site. "No" means a toilet is not available.

SPECIAL SITE RULES–To prevent misuse of boat launching facilities, it has been necessary to make and enforce rules to insure that the access sites are used for their intended purpose, namely recreational boating. The letter code for these rules is as follows:

A – Site is closed 11 p.m. to 4 a.m. No camping, swimming, or loitering. No parking in areas so designated.

B – Site is closed 11 p.m. to 4 a.m. No camping. No parking in areas so designated.

C – No camping. No parking in areas so designated.

D – No swimming, wading, or loitering from 9 p.m. to 7 a.m. No camping at any time. No parking in areas so designated.

E – Site is closed 11 p.m. to 4 a.m. From 9 p.m. to 7 a.m.: No swimming, wading, or loitering. No parking in areas so designated.

F – A fee is charged for using this facility.

G – Site open 8 a.m. to 10 p.m. Motor vehicle permit required.

H – Site open 8 a.m. to 10 p.m. No motor vehicle permit required.

SPECIAL–One or more of the following apply: parking fee, launching fee, closing hours, closing dates. Rules posted at the site.

SPECIAL WATER RULES–In addition to the general boating regulations of Michigan, it has been necessary to make rules to control certain boating activities on some bodies of water. The number code means:

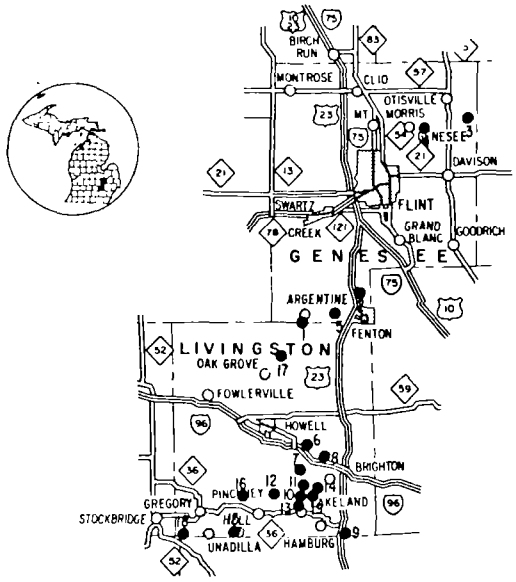
1 – Water skiing and high speed boating permitted 10 a.m. to 6:30 p.m. only.

2 – Water skiing and high speed boating prohibited on all or part of the body of water.

3 – No wake speed in certain areas–check locally.

4 – No motorboats allowed.

5 – No motorboats allowed in certain areas–check locally.



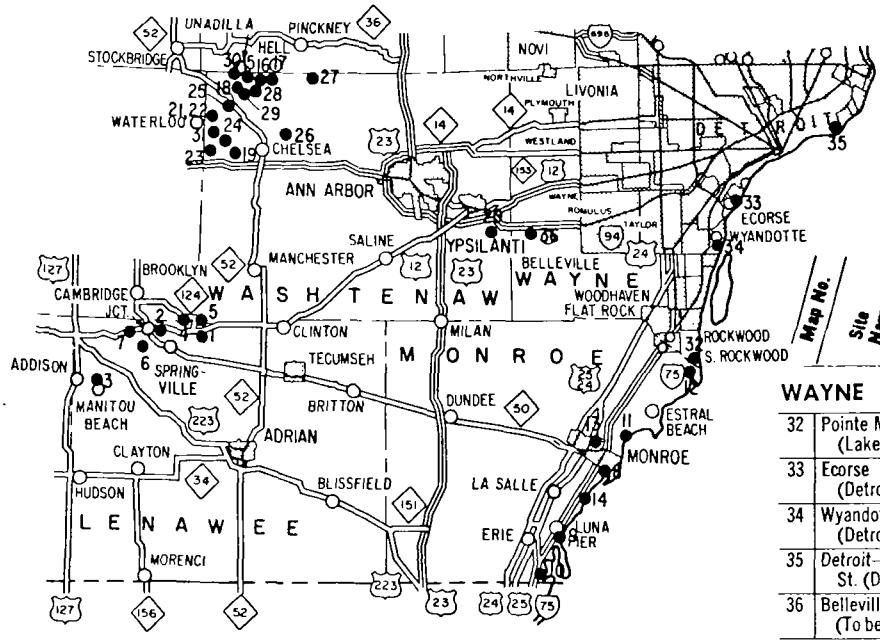
GENESEE

Map No.	Site Name and Body of Water	Water, Acres	Nearest Town	Ramp Code	Toilets?	Special Site Rules	Special Water Rules	Parking	Administrator
1	Lobdell Lake	492	Argentine	3	Yes	C	—	15	WW
2	Lake Fenton	845	Fenton	1	Yes	A	—	50	WW
3	Holloway Reservoir	954	Otisville	1	Yes	—	—	85	County
4	Bluegill (C. S. Mott Lake)	1,200	Genesee	1	Yes	Special	—	150	County
5	Lake Ponemah	424	Fenton	1	Yes	A	—	—	WW

LIVINGSTON

Map No.	Site Name and Body of Water	Water, Acres	Nearest Town	Ramp Code	Toilets?	Special Site Rules	Special Water Rules	Parking	Administrator
6	Lake Chemung	321	Howell	3	Yes	A	—	23	WW
7	Crooked Lake	252	Brighton	2	Yes	C	—	20	WW
8	Woodland Lake	290	Brighton	1	Yes	A	—	20	WW
9	Whitmore Lake	677	Hamburg	2	Yes	A	—	50	WW
10	Bishop Lake	119	Brighton	2	Yes	G	—	20	SP
11	Appleton Lake	56	Brighton	2	Yes	G	—	5	SP
12	Goose Lake	29	Brighton	3	No	—	—	10	SP
13	Pike Lake	29	Brighton	4	No	—	—	5	SP
14	Murray Lake	23	Brighton	3	Yes	—	—	(A)	SP
15	Hiland Lake	50	Hell	4	No	—	—	5	SP
16	Duck Lake	12	Pinckney	4	No	—	—	20	WD
17	Indian Lakes	80	Oak Grove	4	No	—	—	12	WD
18	[illegible]tyre Lake	11	Gregory	4	No	—	—	5	WD
19	[illegible] Lake	19	Brighton	3	No	G	—	5	SP

(A) Ramp for use by campers only. No separate parking.



LENAWEE

Map No.	Site Name and Body of Water	Water, Acres	Nearest Town	Ramp Code	Toilets?	Special Site Rules	Special Water Rules	Parking	Administrator
1	Sand Lake	440	Clinton	3	Yes	A	—	5	WW
2	Allens Lake	63	Cambridge Junction	3	Yes	B	1	15	WW
3	Devils Lake	1,330	Manitou Beach	1	Yes	C	—	45	WW
4	Wamplers Lake	780	Springville	1	Yes	G	—	150	SP
5	Round Lake	65	Springville	3	Yes	G	2	10	SP
6	Deep Lake	65	Cambridge Junction	3	No	—	1	10	WD
7	One Mile Lake	29	Cambridge Junction	4	No	—	—	10	WD

MONROE

Map No.	Site Name and Body of Water	Water, Acres	Nearest Town	Ramp Code	Toilets?	Special Site Rules	Special Water Rules	Parking	Administrator
8	Hoffman Memorial (Lake Erie)	N/A	Monroe	1	Yes	C	3	50	WW
9	Whiting Plant (Lake Erie)	N/A	Erie	4	Yes	C	—	20	WW
10	Halfway Creek (Lake Erie)	N/A	Erie	1	Yes	C	3	22	WW
11	Sterling (Lake Erie)	N/A	Monroe	1	Yes	G	—	100	SP
12	Pointe Mouillee (Mouillee Creek)	N/A	South Rockwood	3	No	—	—	10	WD
13	Hellenberg Field (Raisin River)	N/A	Monroe	1	Yes	—	—	50	City
14	Otter Creek (Lake Erie)	N/A	LaSalle	4	No	C	3	6	WW

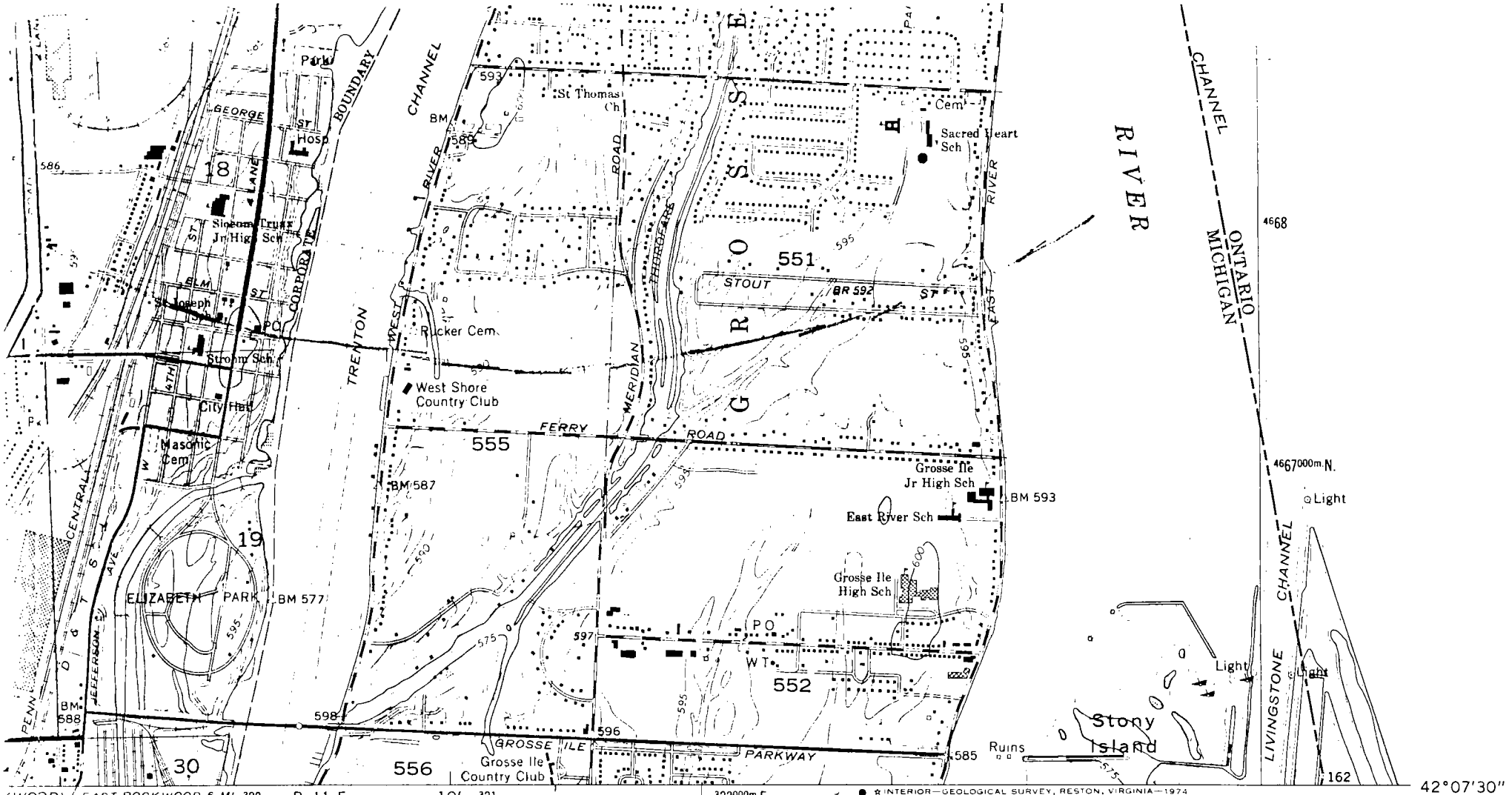
WASHTENAW

Map No.	Site Name and Body of Water	Water, Acres	Nearest Town	Ramp Code	Toilets?	Special Site Rules	Special Water Rules	Parking	Administrator
15	Bruin Lake	145	Unadilla	3	Yes	G	—	8	SP
16	Crooked Lake	50	Hell	3	Yes	G	—	4	SP
17	Half Moon Lake	30	Hell	1	Yes	G	—	34	SP
18	South Lake	193	Unadilla	2	Yes	—	—	4	SP
19	Cedar Lake	76	Waterloo	3	No	—	—	4	SP
20	Ford Lake	1,050	Ypsilanti	1	Yes	—	—	50	JYRO
21	Winnewanna Lake-East	500	Waterloo	3	No	—	—	6	SP
22	Winnewanna Lake-West	500	Waterloo	3	Yes	—	—	5	SP
23	Crooked Lake	113	Waterloo	3	No	—	—	5	SP
24	Mill Lake	163	Waterloo	3	No	—	—	12	SP
25	Green Lake	150	Chelsea	3	No	—	—	10	SP
26	Four Mile Lake	256	Chelsea	3	Yes	—	—	15	WD
27	Portage Lake	644	Pinckney	1	Yes	—	—	20	SP
28	North Lake	200	Unadilla	1	Yes	—	—	10	SP
29	Sullivan Lake	18	Unadilla	3	No	—	—	4	SP
30	Joslin Lake	180	Unadilla	3	No	—	—	8	SP
31	Sugarloaf Lake	205	Waterloo	1	Yes	G	—	(A)	SP

(A) Ramp for use by campers only. No separate parking.

WAYNE

Map No.	Site Name and Body of Water	Water, Acres	Nearest Town	Ramp Code	Toilets?	Special Site Rules	Special Water Rules	Parking	Administrator
32	Pointe Mouillee (Lake Erie)	N/A	South Rockwood	2	Yes	—	3	60	WD
33	Ecorse (Detroit River)	N/A	Ecorse	1	Yes	Special	—	50	City
34	Wyandotte (Detroit River)	N/A	Wyandotte	1	Yes	Special	—	59	City
35	Detroit—St. Jean St. (Detroit R.)	N/A	Detroit	1	Yes	Special	—	240	City
36	Belleville Lake (To be built 1977)	N/A	Belleville	1	Yes	Special	—	120	WW



ALE 000

0 1 MILE

000 4000 5000 6000 7000 FEET

0 1 KILOMETER

< IN ERVAL 5 FEET
> MEAN SEA LEVEL
.S IN FEET—DATUM IS RIVER SURFACE AT
>T. CLAIR 571.7 AND LAKE ERIE 568.6

NATIONAL MAP ACCURACY STANDARDS
ICAL SURVEY, RESTON, VIRGINIA 22092
MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Heavy-duty
Medium-duty
Light-duty
Unimproved dirt
Interstate Route
U. S. Route
State Route

Revisions shown in purple compiled from aerial photographs taken 1973. This information not field checked

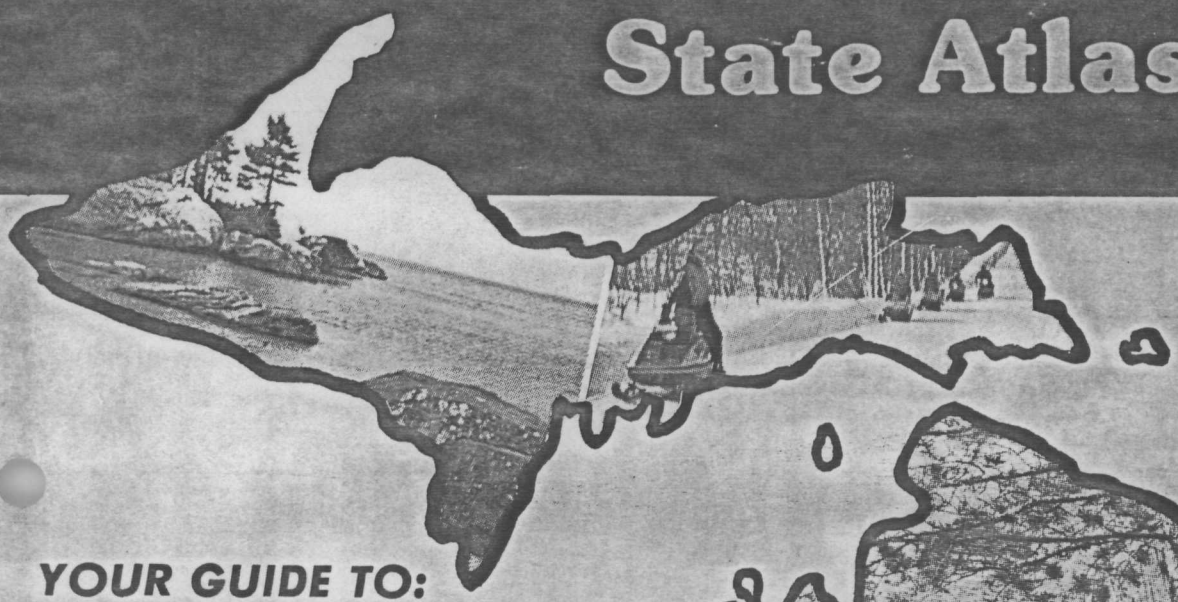
Purple tint indicates e sion of urban areas

WYANDOTTE, MICH.—ONT.

N4207.5—W8307.5/7.5

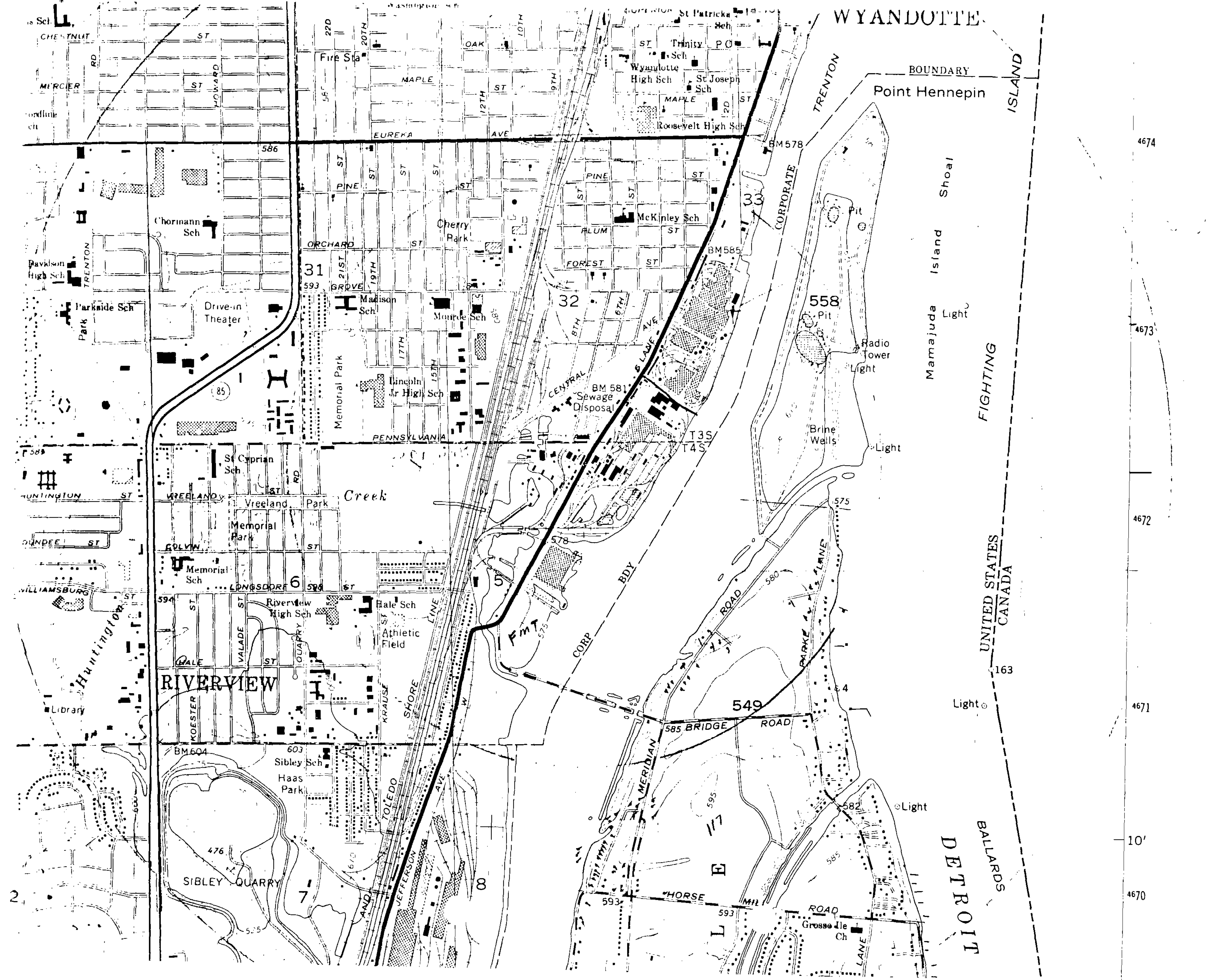
1967
PHOTOREVISED 1973
AMS 4368 II NW—SERIES V862

State Atlas



YOUR GUIDE TO:

- *Vacationing*
- *Fishing*
- *Hunting*
- *Boating*
- *Winter Sports*
- *Historical Attractions*
- *Camping*
- *Golfing*
- *Motels - Restaurants*
- *State and National Parks*
- *Riding - Hiking*
- *Waterfalls*
- *Canoeing*
- *Lakes*
- *Cities - Towns - Villages*
- *County Maps*



WYANDOTTE
CHESTNUT
ST
MERCIER
OAK
MAPLE
Fire Sta
Trinity
Sch
PO
Wyandotte High Sch
St Joseph Sch
St Patricks Sch
HOWARD
22D
20TH
10TH
9TH
12TH
EUREKA
AVE
586
Roosevelt High Sch
BOUNDARY
Point Hennepin
ISLAND
TRENTON
BM 578
4674
PINE
Chormann Sch
Cherry Park
McKinley Sch
PLUM
ORCHARD
FOREST
CORPORATE
33
BM585
Pit
Shoal
Island
Mamajuda
Davidson High Sch
TRENTON
31
593
GROVE
21ST
19TH
Madison Sch
Monroe Sch
32
8TH
6TH
AVE
558
Pit
Light
Parkside Sch
Park
Drive-in Theater
17TH
15TH
Memorial Park
Lincoln Jr High Sch
Radio Tower
Light
4673
FIGHTING
85
CENTRAL
BM 581
Sewage Disposal
LANE
PENNSYLVANIA
T3S
T4S
Brine Wells
Light
St Cyprian Sch
RD
HUNTINGTON
ST
VREELAND
Vreeland
Park
Creek
575
Memorial Park
4672
DUNDEE
ST
COLVIN
578
BDY
Memorial Sch
6
LONGSDORF
ST
5
WILLIAMSBURG
594
Riverview High Sch
Hale Sch
Athletic Field
LINE
VALADE
QUARRY
ROAD
580
LANE
Huntington
HALE
RIVERVIEW
KOESTER
KRAUSE
SHORE
CORP
575
PARKE
UNITED STATES
CANADA
163
Library
549
585
BRIDGE
ROAD
Light
4671
BM604
603
Sibley Sch
Haas Park
TOLEDO
AVE
MERIDIAN
595
582
Light
476
SIBLEY
QUARRY
7
JEFFERSON
8
585
BALLARDS
DETROIT
10′
4670
AND
593
HORSE
MIL
ROAD
593
Grosse Ile Ch
LANE
2